

74, located in Charles City County, Henrico County and Richmond City is found on Map 8. District 48, located in Arlington and Fairfax Counties, and is found on Map 9. District 13, located in Prince William County and Manassas Park City, and is found on Map 10. Finally, Districts 17 (Botetourt, Roanoke County and Roanoke City) and 22 (Franklin, Campbell and Bedford Counties plus Lynchburg City), are found on Map 11.

PROBABLE REASONS FOR THE SHAPE OF DISTRICTS 74 AND 95

67. Once again, I should make it clear that I did not play any part in the drafting of the 2011 House of Delegates Plan HB 5055. But having 40 years of redistricting plan drafting experience places me in a unique position to ascertain possible motivation for the way individual districts have been crafted. I gave both District 74 and 95 a closer examination to understand why these two districts are configured as drawn.
68. First is the issue of total district population. Table 11 lists all 12 African-American Districts. The column on the right of Table 11 compares the 2010 Decennial population of each district, as it existed prior to the 2011 redistricting, to the ideal district populations for House districts being drafted in 2011. All but one of the 12 African-American districts were significantly under-populated in terms of the 2010 Decennial Census population numbers. Only district 74 was over-populated (by 0.18%) but just slightly. The cumulative under-population of the 12 districts was 98.95%. What this means is that because of the shifts in relative population across Virginia, the 12 African-American districts only contained enough population to draw 11 districts.

69. These districts were also clustered together so that needed areas of population had to be drawn in from neighboring districts, which could not also be African-American districts. Districts 92 and 95, in Hampton and Newport News were adjacent. Districts 77, 80, 89 and 90, in the Norfolk area were adjacent. Finally, the remaining 6 districts (63, 69, 70, 71, 74 and 75) were all adjacent in the greater Richmond Area. Those who have actually drafted redistricting plans in a legislative setting understand that these population issues cannot be solved in a vacuum. In other words, a legislative plan, particularly for a lower chamber, is a highly complex puzzle. Although every legislator would like to believe that the entire map should originate from his or her own district, many policy issues must be resolved to draft a map which can be enacted.

70. Another paramount issue is "core retention". Almost every legislator wants to keep the majority of his, or her, old district in his, or her, new, district. There is also the issue of incumbent residences. Table 11 contains two district core retention factors. Column 2 shows the portion of the population of the old district which was retained in the new district. Column 3 shows the portion of the new district population which is from the old district. As is demonstrated from Table 11, the core retention rate for the 12 African-American districts was very high; even with the need to add significant new population to the 2011 districts.

71. Table 12 lists all 100 of the districts in the 2011 House of Delegates Plan HB 5005. Column 2 show the percentage of the new district population which was in the old district. One should note that three new House districts (2, 10 and 87) do not contain any of the population of the old districts with the same number. They

should be considered to have been collapsed and moved elsewhere in the State. This table does not consider those members whose residences are no longer in their new districts. A number of incumbents found their residences were now located in a new district with another incumbent's residence. The choice, of course, is either to move, run against the other incumbent, seek another political office, or retire. It should be noted that not one of the African-American incumbents was paired with another legislator and the core retention percentages for the African-American districts are higher than for the districts of the entire plan. This is another factor which influenced the shape and locations of these minority districts.

72. The new District 74 is located in almost the same place as the 1991 and 2001 District 74 (See Map 20 for a side-by-side version of all three districts). See Maps 4 and 13 for the location of the old and new District 74 and Map 19 for the location of 1991 District 74. All three versions of House District 74 (1991, 2001 and 2011) included Charles City County and extended in a long narrow configuration along the northeastern border of Henrico County. District 74 could have been withdrawn from Charles City County, but that would have produced a population ripple which could have disrupted the cores of the neighboring African-American districts. It is also important to note that the 2001 version of House District 74 extended into Hopewell City across the James River which, in my expert opinion, makes the 2011 version of District 74 superior in compactness to the 2001 version of that district. In 1991 the House of Delegates drew the districts, and they certainly did not subsequently object to District 74's configuration then. The district configuration was not a nefarious scheme to violate civil rights. It was

essentially pure redistricting politics, favoring the core retention of the districts of African-American incumbents.

73. The area between the York and James Rivers is commonly referred to as "The Peninsula". There are 6 districts located in the area bounded by western and northern boundary of James City County, the York River, the James River and Chesapeake Bay (Districts 91 to 96). On the 2001 map (See Map 18), old District 64 also crossed the James River into the Peninsula. When the 2011 Plan was drafted (See Map 17), there was not enough population for the new House District 64 to cross over the James River, but 6 new districts could be constructed within the portion of the Peninsula from James City southeast to the end of the Peninsula. That was exactly what the plan drafters did. It was a very logical solution. I have included Map 14, which is the old District 95. Old District 95 was the most underpopulated African-American district at -15.16%, was next to old District 92, which was 11.24% underpopulated.

74. The plan drafters, decided to convert District 93 into a GOP district and use the strong Democrat areas of the old District 93 to bring the population of new Districts 92 and 95 up within 1% of the ideal district population. The new District 93 was shifted north into the area which had been located in the old District 64. This left new Districts 91, 94 and 96 as GOP districts.

CONTIGUITY OF HB 5005

75. I have examined the 2011 House of Delegates Plan with respect to the requirement of contiguity and find no issues in this plan. No districts cross the wide tidal estuaries of the James, York and Rappahannock Rivers and the only crossing of

the Chesapeake Bay is from Northampton County to Norfolk City, which is required to give District 100 enough population (34,484) to bring it up to the ideal district population.

CONCLUSIONS

76. This map and the individual majority minority districts contained therein are at least as compact and contiguous as the 1991 and 2001 maps and individual majority minority districts which were approved under the Virginia constitutional standards in *Jamerson* and *Wilkins*.
77. This map is consistent with lower chamber maps in similarly situated states.
78. The high degree of individual district core retention in the 2011 House map was a major factor in the construction of the map. This is particularly the case with regard to the majority minority districts.
79. There was a high degree of protection extended to incumbents, particular in the case of minority incumbents and Republican incumbents.
80. There were no negative contiguity issues in HB 5005.

I declare under penalty of perjury that the foregoing is true and correct.

Executed this 10th day of April, 2015

A handwritten signature in black ink, appearing to read "Thomas B. Hofeller", is written over a horizontal line.

Thomas Brooks Hofeller, Ph.D.

Exhibit 1

DEFENDANT-INTERVENORS TX 014 - Page 025

DEFENDANT-INTERVENORS TX 102 - Page 150

RESUME

Thomas Brooks Hofeller, Ph.D.

6701 Pointe Vista Circle, Raleigh, North Carolina 27615

Home: (984) 202-5193 – Cell: (703) 623-0764

Qualifications:

A varied career in government, business, academia and politics. Positions of significant responsibility, requiring intelligence, scholarship, communications skills, creativity and leadership include:

- ◆ Senior executive management of an office within a large government agency, planning and directing operations of a staff with a diverse number of missions while coordinating activities ranging across an entire agency.
- ◆ Successful completion of a Doctorate in Government requiring research and writing skills and the ability to communicate in an academic setting. Also includes a firm grounding in the philosophical and political roots of the American Governmental System.
- ◆ Litigation support and courtroom experience as a qualified expert witness in federal court. Clear presentation of difficult demographic and statistical concepts – making them understandable to non-technical audiences.
- ◆ Setting up a new U. S. House subcommittee and conducting oversight, developing legislation and interacting with leadership. Experience in statistical, demographic and budgetary analysis.
- ◆ Experience in management and information systems – including database construction, geographic information systems and creation of user interfaces that allow access by persons without extensive computer skills.
- ◆ Creating and managing small businesses, including budgeting, human resources, facilities management, accounting and shareholder interface.
- ◆ Strategic and tactical analysis of political and demographic data for campaigns and political organizations. Understanding of survey design and interpretation, political resource targeting, list development and use of direct mail.

Areas of Expertise:

- ◆ **Operations:** Recruiting, training and directing staffs for existing and newly instituted projects in government and national political organizations. Private sector experience as a business owner and CAO. Proven ability to organize and direct multiple projects with effective use of delegation. Able to function as a team player in both management and support positions.
- ◆ **Communications:** Ability to develop and deliver engaging and informative presentations involving difficult concepts and issues to decision-makers, the public and press. Effective in preparation of affidavits and exhibits as well as giving depositions and delivering courtroom testimony.
- ◆ **Information Technology:** Expertise in analysis of complex technical problems involving large amounts of data – both for analysis and practical use in business, government and politics. Able to break down information and develop effective solutions. Ability to interface between highly technical personnel and management.

Thomas B. Hofeller

Resume

April 2015

- ◆ Considerable experience in integration of mapping and data (geographic information systems).
- ◆ **Budget & Programs:** Experience in budget formulation and managing accurate accounting systems in the private and public sectors.

Education:

- ◆ **Claremont Graduate University**, Claremont, CA – Ph.D. in Government - 1980
- ◆ **Claremont McKenna College**, Claremont CA – B. A. in Political Science - 1970
- ◆ **U. S. Navy, Electronics School**, Treasure Island, CA, Graduate -1966

Publications:

- ◆ Thomas S. Engeman, Edward J. Erler and Thomas B. Hofeller (1980). **The Federalist Concordance**. Chicago: University of Chicago Press.
- ◆ Grofman, Bernard and Hofeller, Thomas B (1990). “**Comparing the Compactness of California Congressional districts Under Three Different Plans**”. In Bernard Grofman (ed) *Political Gerrymandering and the Courts*. New York: Agathon.
- ◆ Richard Niemi, Bernard Grofman, Thomas Hofeller, and Carl Carlucci (1990). **Measuring the Compactness and the Role of a Compactness Standard in a Test for Partisan Gerrymanderings**. *Journal of Politics*.
- ◆ **Reports and affidavits prepared for, and testimony in, numerous court cases** (listed below).

References:

Current and recent employer references are available and will be furnished upon request.

Thomas B. Hofeller

Resume

April 2015

Experience:

Geographic Strategies LLC
7119 Marine Drive
Alexandria, Virginia 22307

Partner

May 2011 – present

- ❑ Geographic Strategies provides redistricting services clients including database construction, strategic political and legal planning in preparation for actual line drawing, support services and training on the use of geographic information systems (GIS) used in redistricting, analysis of plan drafts, and actual line-drawing when requested. The corporation and its principals also provide litigation support.

State Government Leadership
Foundation
1800 Diagonal Road, Suite 230

Redistricting Consultant

April 2011 – April 2012

Alexandria, VA 22314

Contracting Officer: J. Christopher Jankowski
Executive Director
(571-480-4861)

- ❑ Retained as a consultant to state legislatures and statewide elected officials in all aspects of their work on the 2011-2012 redistricting process.

Areas of consultation:

- ◆ Develop strategic and tactical plans for Legislatures and statewide elected officials to develop and defend redistricting plans for legislative and congressional districts.
- ◆ Providing assistance in actual redistricting plan drafting and analysis.
- ◆ Providing a linkage between complex legal standards and their practical application to plan drafting in difficult political and technical environments.
- ◆ Provide assistance in redistricting litigation
- ◆ Identification of specialized GIS software, database and hardware systems to be used by stakeholders.
- ◆ Ongoing strategic, technical and legal support to those involved in redistricting in all states.
- ◆ Development of a clearinghouse of redistricting activities throughout the nation and analysis of the effects of the process on future elections.

Thomas B. Hofeller

Resume

April 2015

**REPUBLICAN NATIONAL
COMMITTEE**

310 First Street, S.E.

Washington, DC 20003

Redistricting Consultant

May 2009 – April 2011

Contracting Officer: John Phillippe
RNC Chief Counsel
(202) 863-8638

☐ Retained as a consultant to recreate a new department to coordinate the redistricting activities of the National Committee and the greater GOP community in preparation and execution of the 2011 redistricting Areas of responsibility and to support the Committee's 2011 through 2012 redistricting efforts:

- ◆ Developed a strategic plan for the Committee to best position itself for maximum success in this highly competitive process.
- ◆ Liaison and training with members of Congress, legislators, key statewide officials, state parties and other divisions within the Committee to ensure a high level of political, technical and legal preparation.
- ◆ Recruitment and training of a technical and legal staff.
- ◆ Providing a linkage between complex legal standards and their practical application to plan drafting in difficult political and technical environments
- ◆ Identification of specialized GIS software, database and hardware systems to be used by the Committee and other stakeholders.
- ◆ Ongoing strategic, technical and legal support to members of congress and those involved in redistricting in all states, including plan drafting.
- ◆ Development of a clearinghouse of redistricting activities throughout the nation and analysis of the effects of the process on future elections.

**DEPARTMENT OF
AGRICULTURE
FARM SERVICE AGENCY**

1400 Independence Avenue

Washington, DC 20250

**Associate Administrator
for Operations and
Management**

June 2004 – January 2009

Supervisor: Teresa C Lasseter, Administrator
Farm Service Agency
(229) 890-9127

☐ Associate Administrator providing management and oversight to staff with diverse missions supporting the activities of the entire Farm Service Agency (FSA).

Areas of responsibility:

- ◆ Provides oversight and guidance to the 1,100 person staff of the Deputy Administrator for Management. These functions include management services, human resources, financial management, budgeting, and information technology.

Thomas B. Hofeller

Resume

April 2015

- ◆ Directs the activities of the Office of Civil Rights which performs all of the EEO functions for the Agency, as well managing FSA's diversity programs.
- ◆ Provides oversight and guidance to the Office of Business and Program Integration. This office supports a wide range of cross-cutting activities including economic policy analysis, strategic planning, outreach, state and county office review, county service center integration, emergency planning, county office reviews and audits, e-Government, and program appeals and litigation.
- ◆ Has primary oversight of the business realignment process underway in the Agency. This realignment includes such projects as Agency-wide enterprise architecture development, field office realignment, and concurrent changes to the Agency's business processes. This realignment is necessary to allow the Agency to meet the present and future challenges involved in providing the best possible customers service and implementation the President's Management Agenda.
- ◆ Spearheads the ongoing reform of the FSA county committee election system which included the drafting of guidelines just published in the Federal Register.

**DEPARTMENT OF
AGRICULTURE
FARM SERVICE AGENCY**
1400 Independence Avenue

**Director, Office of
Business and Program
Integration**

Apr. 2003 – June 2004

Washington, DC 20250

Supervisor: Verle Lanier, Associate Administrator for
Operations and Management (retired)
(301) 424-5776

- Director of a senior level office directing the activities of subordinate staffs with diverse missions supporting the overall activities of the Farm Service Agency.

Areas of responsibility:

- ◆ Provided oversight and guidance to the 75-person staff of the Office of Business and Program Integration. This office supported a wide range of cross-cutting activities including economic policy analysis, strategic planning, outreach, state and county office review, county service center integration, emergency planning, county office reviews and audits, e-Government, and program appeals and litigation.
- ◆ Directed the development of administrative strategies essential to the successful management of e-Government initiatives. Coordinated citizen-centered eGovernment initiatives.
- ◆ Provided centralized direction for the Agency's strategic plan in compliance with the Government Performance and Results Act of 1993.
- ◆ Coordinated outreach efforts for all FSA programs to enhance participation of small or limited resource farmers and ranchers to provide equal access to programs striving to acquire and maintain economic viability for family farmers and ranchers.
- ◆ Directed the preparation of policies and dockets on national program determinations to be submitted for CCC Board consideration and Federal Register publications.

Thomas B. Hofeller

Resume

April 2015

**REPUBLICAN NATIONAL
COMMITTEE**

310 First Street, S.E.

Redistricting Director

Jul. '99 – Mar. 2003

Washington, DC 20003

Supervisor: Thomas Josefiak, former RNC Chief Counsel
(703) 647-2940

- ☐ Hired to create a new department to coordinate the redistricting activities of the National Committee mandated by the release of data from the 2000 Decennial Census.

(See the description of present position.)

**U. S. HOUSE SUBCOMMITTEE
ON THE CENSUS**

Staff Director

Feb. '98 - Jul. '99

Supervisor: Hon. Dan Miller, Chairman
(202) 225-5015

- ☐ Staff Director at inception of this oversight subcommittee, created by the House in February of 1998, to monitor the preparations for and the execution of the 2000 Decennial Census. Directed all day-to day operations of the subcommittee including:
 - ◆ Recruitment and training of a staff for a new subcommittee.
 - ◆ Liaison with the Director and Senior Staff of the Census Bureau, the Department of Commerce, and U.S. Senate Staff involved in census oversight.
 - ◆ A complete examination of the preparations underway at the Census Bureau for conduct of the 2000 Decennial Census.
 - ◆ An examination of the proposed statistical methods proposed by the Bureau to improve coverage of the Census.
 - ◆ Reviewed and made recommendations to the Chairman and House Leadership regarding census policy.
 - ◆ Coordination with Government Accounting Office personnel involved in census oversight.
 - ◆ Preparation and support for oversight hearings conducted by the members of the Subcommittee.
 - ◆ Interface between the academic statistical community and the subcommittee in the development of census policy.
 - ◆ Liaison with census stakeholders in general, with particular attention to members of the Decennial Census Advisory Committees.

**U. S. HOUSE COMMITTEE
ON HOUSE OVERSIGHT**

Professional Staff

Nov. '97 - Feb. '98

Supervisor: Hon. William M. Thomas, Chairman
(202) 225-2915

Thomas B. Hofeller

Resume

April 2015

- ☐ Involved in the oversight activities of the Committee that supervises the operations of the U.S. House of Representatives. Advised the Chairman and House Leadership on congressional policy with regard to all census operations prior to the establishment of the Subcommittee on the Census.

PARTES CORPORATION

Director of Administration Mar. '96 - Nov. '97

Kirkland, Washington

Supervisor: Mark Schnitzer, Chairman

- ☐ Chief Administrator of a software development company specializing in the creation of databases used by investment professionals to analyze information on securities.

Information was downloaded, parsed, and reformatted from the Securities and Exchange Commission's EDGAR database and other relevant sources. Was responsible for all administrative functions of the corporation including:

- ◆ Procurement, renovation and management of facilities housing the company.
- ◆ All human resource activities.
- ◆ Accounting and payroll.
- ◆ Liaison with attorneys and shareholders.

CAMPAIGN MAIL & DATA, INC

Professional Staff

Nov. '93 - Mar. '96

Falls Church, Virginia

Supervisor: John Simms, President
(703) 790-8676

- ☐ Supervised development and maintenance of geographic databases that were integrated with the company's various political and commercial lists. Created a new department that collected and converted voter lists from states, counties and towns.

**NATIONAL REPUBLICAN
CONGRESSIONAL COMMITTEE**

Redistricting Director

Mar. '89 – Nov. '93

320 First Street, S.E.
Washington, DC 20003

Supervisor: Maria Cino, Chief of Staff

- ☐ Created a new department to coordinate the redistricting activities of the NRCC and provide support to all GOP members of the U.S. House and their staffs.

Areas of responsibility:

- ◆ Recruitment and training of a technical staff.

Thomas B. Hofeller

Resume

April 2015

- ◆ Development of specialized GIS software, databases and hardware systems to be used by the Committee and members of Congress.

**REPUBLICAN NATIONAL
COMMITTEE**

MIS Director

Jan. '82 – Mar. 89

310 First Street, S.E.
Washington, DC 20003

- ❑ Transformed the Committee's computer capabilities from a single mainframe system operated completely within a computer division into a building-wide network, utilized by all divisions and from remote locations. Supervised all the Committee's data processing activities, including database and software development. Directed research activities involving analyses of demographic and election data. Primary computer consultant to the GOP's state and county party organizations.

**ROSE INSTITUTE OF STATE
AND LOCAL GOVERNMENT**

Associate Director

1973 – 1981

Claremont McKenna College
Claremont, California

- ❑ Co-Founder of this Southern California research center specializing in the examination of current financial and political issues affecting California's state and local governments. Supervised staff and day-to-day operations, directed software and database development, managed research projects and assisted in fundraising.

**COMPASS SYSTEMS, INC.
AND LOCAL GOVERNMENT**

Vice President

1970 – 1973

San Diego, California

- ❑ Part of the management team that developed the first computerized geographic mapping and data retrieval system used by the California State Assembly for redistricting and demographic analysis. Directly supervised programming and database development staffs.

UNITED STATES NAVY

Petty Officer 2nd Class

1965 – 1969

- ❑ Electronics Technician. Served on USS Porterfield, DD682, in Tonkin Gulf operations during Vietnam War. (Honorable Discharge)

Summary of Participation in Lawsuits:

Shaw v. Hunt, 92-202-CIV-5-BR, U.S. District Court for the Eastern District of North Carolina, Raleigh Division (1993-4)

This case was the second trial phase following the U.S. Supreme Court's reversal of the lower court in Shaw v. Reno (1993). Prepared alternative plans for presentation to the court. Prepared political and demographic analyses of the state's plans, along with numerous exhibits supporting the plaintiffs' complaints. Gave a deposition and served as plaintiffs' primary expert witness at trial.

Arizonans for Fair Representation v. Symington, CIV 92-0256, U.S. District Court Arizona (1992), aff'd mem. sub nom. Arizona Community Forum v. Symington, 506 U.S. 969 (1992)

Prepared an affidavit evaluating the three major plans submitted to court for redistricting of Arizona's six congressional districts. Plans were examined with regard to all major redistricting criteria. Also examined minority voting strength in proposed new sixth district in State Senate Plan. Gave expert testimony in trial phase. Drafted a new map for presentation in court that was adopted, with minor changes, by the three-judge panel.

De Grandy v. Wetherell, No 92-40015-WS, U.S. District Court Florida (1992)

Prepared model plans and submitted affidavits evaluating alternative plans for two of the parties in the congressional phase of the case and gave testimony on the political and voting rights implications of various other plans. Presented an affidavit and gave expert testimony in the legislative phase of the case for the De Grandy plaintiffs.

Good v. Van Straten, 800 F. Supp. 557, U.S. District Court Eastern & Western Michigan (1992)

Prepared compactness analysis of plans submitted to court to redistrict Michigan's congressional districts. Gave testimony on compactness theories and other relevant redistricting criteria.

Pope v. Blue, U.S. District Court Western District of North Carolina (1992)

Prepared an affidavit containing compactness analysis and political analysis of the plan passed by North Carolina Legislature and approved by U.S. Department of Justice.

Ketchum v. Byrne, 740 F.2d 1398, cert. denied City Council of Chicago v. Ketchum, 471 U.S. 1135 (1985), on remand, Ketchum v. City of Chicago 630 F. Supp. 551 (N.D. Ill. 1985)

Consultant to African-American plaintiffs (P.A.C.I.). Assisted in building Plaintiffs' political and demographic database, performed a racial and ethnic analysis of City of Chicago, gave a deposition, and testified in court. Participated in second remedy phase of case, gave a second deposition, was prepared to give testimony (the case was settled before retrial).

Thomas B. Hofeller

Resume

April 2015

Carrillo v. City of Los Angeles, No. CV-85-7739 JMI-JRX (unreported) (C.D. Cal. 1986)

Consultant to Mexican American Legal Defense Fund (MALDEF). Constructed database, performed analysis of ethnic voter registration levels, analyzed various plans submitted by all parties, submitted affidavit to the court.

McNeil v. Springfield School District, 656 F. Supp. 1200, 66 F. Supp. 1208 (C.D. Ill 1987), 851 F.2d, 937 (7th Cir. 1988)

Consultant to counsel for Springfield School Board. Constructed demographic database, performed analyses on various proposed districts, gave deposition, presented affidavit to court. Prepared an analysis determining levels of African-American voting strength in proposed districts.

State of Mississippi v. United States, 490 F. Supp. 569 (D.C.D.C. 1979)

Principle consultant to Joint Reapportionment Committee of Mississippi State Legislature. Compiled databases, drew plans, prepared analysis for the legislature, and gave general redistricting advice to Committee Chairman and Counsel. Gave an extensive deposition and testified before the District Court in DC. Assisted in the preparation of all briefs.

Badham v. Eu, 568 F. Supp. 156; 721 F.2d 1170 (1983); -- F.Supp. -- (Apr. 21 1988), appeal docketed, No. 87-1818 56 U.S.L.W. 3791 (U.S. May 4 1988)

Principle technical consultant to counsel for Badham Plaintiffs and Republican National Committee. In charge of all database construction, development of sample court plans, analyses of Burton Plans and preparation of maps, charts and other materials for trial. Submitted affidavits.

Bandemer v. Davis, 478 U.S. 109 (1986)

Consultant to counsel for amicus, Republican National Committee. Prepared a demonstration plan for brief submitted to U.S. Supreme Court.

California Legislature v. Reinecke, 6 Cal. 3d 595 99 Cal. Rptr. 481, 492 P.2d 385 (1972)

As consultant, drafted redistricting plan for California State Senate and Assembly that were subsequently accepted by California Redistricting Commission.

Jordan v. Winter, 541 F. Supp. 1135 (N.D. Miss. 1982)

Performed analyses and gave court testimony on behalf of the defendants.

Gingles v. Edmisten, 590 F. Supp. 345 (N.D.N.C. 1984), aff'd in part and rev'd in part Thornburg v. Gingles 478 U.S. 30 (1986)

Consultant to Attorney General. Performed demographic analysis of state with regard to creation of African-American districts for North Carolina General Assembly. Gave deposition and testimony.
Pg. 10 of 13

Thomas B. Hofeller
fied in court on behalf of Legislature.

Resume

April 2015

City of Port Arthur v. United States, 459 U.S. 159 (1982)

Consultant to City Attorney. Performed analysis of racial content of City Council Districts. This was required for the case required because the 1980 Decennial Census data were not yet available. Analysis required extensive residential survey to determine racial characteristics of individual districts. Gave a deposition in the case.

Ryan v. Otto, 661 F.2d 1130 (7th Cir. 1981)

Consultant to Republican plaintiffs and Illinois Congressional Delegation. Drew alternative plans for presentation to Court, gave deposition and testimony.

Rybicki v. State Board of Elections, 584 F. Supp. 849 (N.D. Ill. 1984)

Principle technical consultant to State House of Representatives and the Senate Minority Caucus. Supervised construction of all political and demographic databases. Responsible for design and programming of House's computerized redistricting information system. Analyzed and drafted numerous redistricting plans. Gave depositions and testified at trial.

La Comb v. Growe, 541 F. Supp. 145 (D.Minn.), aff'd sub nom. Orwall v. La Comb, 456 U.S. 966 (1982)

Consultant to Minority members of Congressional Delegation. Drafted a plan for presentation to Court and submitted an affidavit.

Karcher v. Daggett, 462 U.S. 725 (1983), 467 U.S. 1222 (1984)

Participated in presentation of briefs on Republican side. Consultant to members of New Jersey Congressional Delegation.

Flanagan v. Gillmor, 561 F. Supp. 36 (S.D.Ohio 1982) Brown v. Brandon, (unreported), (S.D.Ohio Jan. 30, 1984), as modified (Feb. 13, 1984), aff'd 467 U.S. 1223 (1985)

Consultant to State Legislature. Modified 1981 congressional district redistricting plan to conform to "one person, one vote" standard imposed by decision of the Court.

Massachusetts Republican State Committee v. Connolly, 679 F. Supp. 109 (D. Mass. 1988)

Consultant to counsel for plaintiffs. Examined evidence submitted in regard to 1985 Massachusetts State Census (particularly for Boston), analyzed legislative redistricting plan, submitted affidavit, gave deposition.

Sinkfield v. Bennett, Civil Action CV 93-689-PR (Circuit Court of Montgomery County, Alabama)

Thomas B. Hofeller

Resume

April 2015

Gave testimony supporting the replacement of the Alabama congressional plan drawn by the Federal Court with a plan drawn by the Circuit Court.

Mississippi State Conference of the NAACP v. Haley Barbour, Civil Action No. 3:11-ev-159 TSL-EGJ-LG (SD Mississippi, Jackson Division – 2011)

Prepared a declaration for the intervenors analyzing the compactness and deviations of various legislative plans submitted to the Court for consideration.

Dickson v. Rucho, Civil Action 11 CVS 16896 and North Carolina State Conference of the NAACP v. State of North Carolina, Civil Action 11CVS 16940 (General Court of Justice, Superior Court Division, Raleigh, North Carolina – 2011)

Submitted two affidavits and gave a deposition concerning my role as a consultant to the General Assembly with regard to the redistricting of North Carolina State Senate and State House of Representative districts as well as the redistricting of that state's congressional districts. Testified at hearing before 3-judge panel.

Boone v. Nassau County Legislature, Civil Action CV 11-cv 02712 (Supreme Court of the State of New York, County of Nassau - 2011)

Prepared an affidavit evaluating the 2011 redistricting plan enacted by the Nassau County Legislature and other sample plans presented by the Plaintiffs, with particular attention to the efficacy of the use of the U.S. Census Bureau's American Community Survey for measuring compliance with the provisions of Section 2 of the Federal Voting Rights Act.

Petteway v. Henry, Civil Action CV 11-411 (SD Texas, Galveston Div. 2011)

Prepared and presented at trial an alternative redistricting plan Galveston County's commissioner districts to the court for defendant intervenors.

Pearson v. Koster, Civil Action 11AC-CC00624 (Circuit Court of Cole County, Missouri, Div. II - 2012)

Prepared an affidavit evaluating the compactness of Missouri's newly enacted congressional districts (2011) in light of the State Supreme Court's remand of this case for determination of whether or not, in light of Plaintiffs' alleged claims to the contrary, the districts reflected in H.B. 193 were sufficiently compact to meet the requirement contained in the Missouri Constitution that districts be "composed of territory as compact as may be." Served as the expert witness at trial for the defendant intervenors.

Bob Johnson v. State of Missouri, Civil Action 12AC-00056 (Circuit Court of Cole County, Missouri 2012)

Prepared an affidavit analyzing the compactness and deviations of the enacted State House of Representative districts.

Harris v. Arizona Independent Redistricting Commission, Civil Action cv-12-0894-PHX-ROS (United States District Court, District of Arizona 2012)

Pg. 12 of 13

Thomas B. Hofeller

Resume

April 2015

Prepared affidavits analyzing the state legislative districts enacted by the Arizona Independent Redistricting Commission concerning population deviations, ethnic and racial characteristics and adherence to other neutral redistricting criteria. Presented expert testimony at trial.

Cynthia Hauser v. Martin O'Malley, Civil Action September Term 2012, Misc. No 5 – 2012, (Maryland Court of Appeals)

Prepared a declaration analyzing the State Senate and State House of Maryland enacted by the Governor following the 2010 Census and comparing both plans to senate and house plans submitted by plaintiffs.. Conclusions were made concerning the integrity of county lines, and district deviations as well as adherence to the provisions of the federal Voting Rights Act.

Kermit L. Moore, Jr. v. State of Tennessee, In the Chancery Court Case No. 120402-III (2012)

Prepared an affidavit analyzing the State Senate redistricting plan enacted by the Legislature for the 2012 elections and compared it to a plan submitted as a bill by the opposition. Conclusions were made analyzing the compliance of both plans with the federal and state provisions of one-person/one vote.

David Harris v. Patrick McCrory, Civil Action No. 1:13 CV-00949 (United States District Court, Middle District of North Carolina Durham Division 2013)

Retained by Defendant's counsel to prepare a declaration in response to plaintiffs' expert report concerning the congressional redistricting plan enacted by the North Carolina General Assembly in 2011. Gave a deposition concerning the construction and characteristics of the congressional district contained in the enacted plan as well as other relevant congressional maps.

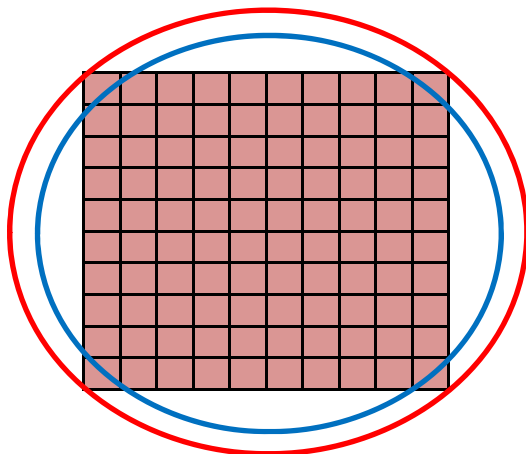
Terry Petteway v. Galveston County, Texas, Civil No. 3:-cv-00308, United States District Court, Southern district of Texas, Galveston Division 2013)

Retained by Defendant's counsel to prepare a redistricting map for Galveston County's Justice of the Peace Precincts, prepared a declaration in response to plaintiffs' experts' reports and gave testimony at trial.

North Carolina State Conference of the NAACP v. Patrick Lloyd McCrory, 1:13 CV-658 (United States District Court, Middle District of North Carolina 2013)

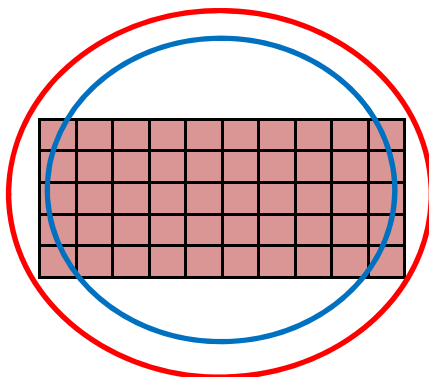
Retained by Defendant's counsel to prepare an expert report summarizing a study of information from the voter files of North Carolina's State Board of elections as compared to the North Carolina Department of Motor Vehicles' (DMV) customer file as well as locations of DMV offices proximity to potential registered voters who do not appear to have drivers licenses or DMV IDs. Performed analyses of demographics and registration information with regard to this information. Analyzed the locations and hours of one-stop voting centers.

FIGURE 1
HYPOTHETICAL LEGISLATIVE DISTRICTS A, B & C
Showing Reock and Polsby Circles



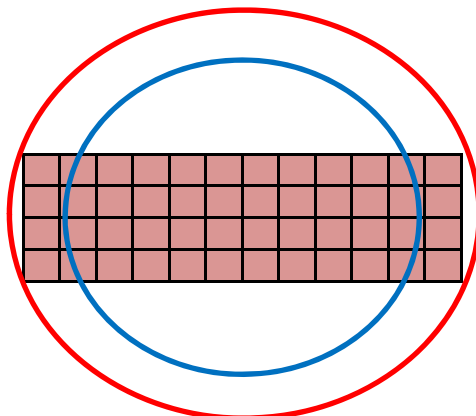
DISTRICT A

Reock Circle is Red. Reock Score is 0.6367
Polsby-Popper Circle is Blue. Polsby-Popper Score is 0.7853



DISTRICT B

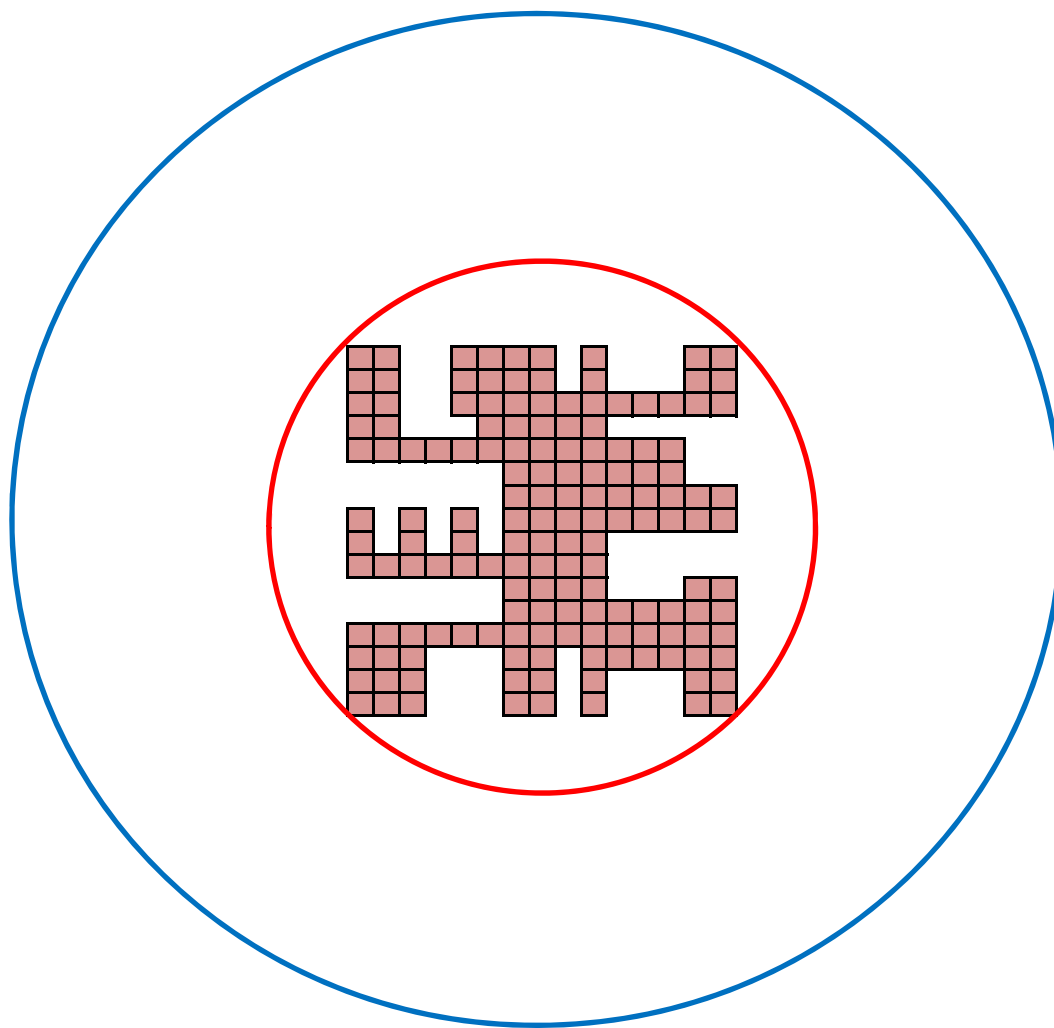
Reock Circle is Red. Reock Score is 0.509
Polsby-Popper Circle is Blue. Polsby-Popper Score is 0.698



DISTRICT C

Reock Circle is Red. Reock Score is 0.380
Polsby-Popper Circle is Blue. Polsby-Popper Score is 0.589

FIGURE 2
HYPOTHETICAL LEGISLATIVE DISTRICT D
Showing Reock and Polsby Circles

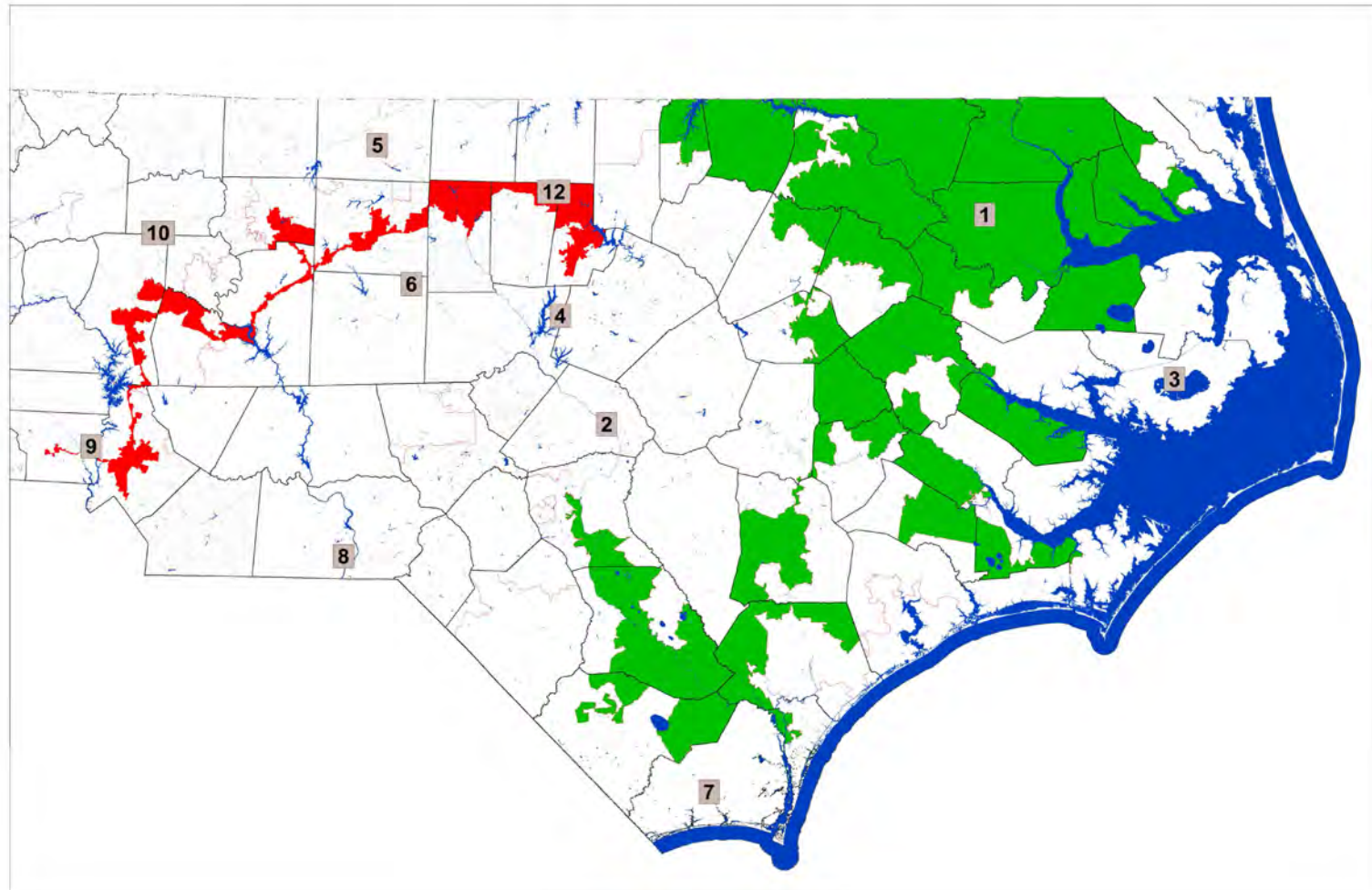


Reock Circle is Red. Reock Score is .405

Polsby-Popper Circle is Blue Polsby-Popper Score is .082

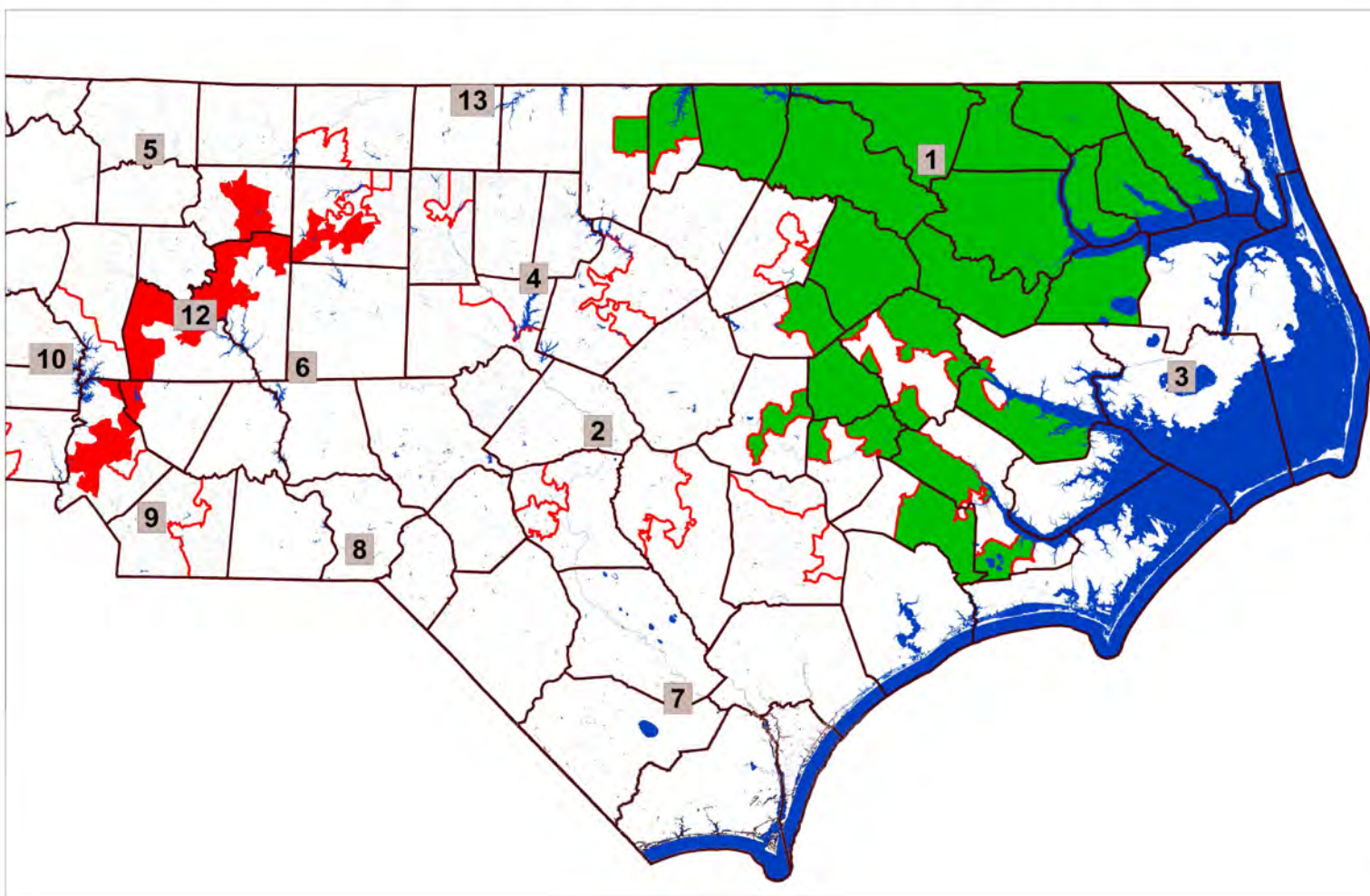
Map 1

North Carolina Congressional Districts 1992

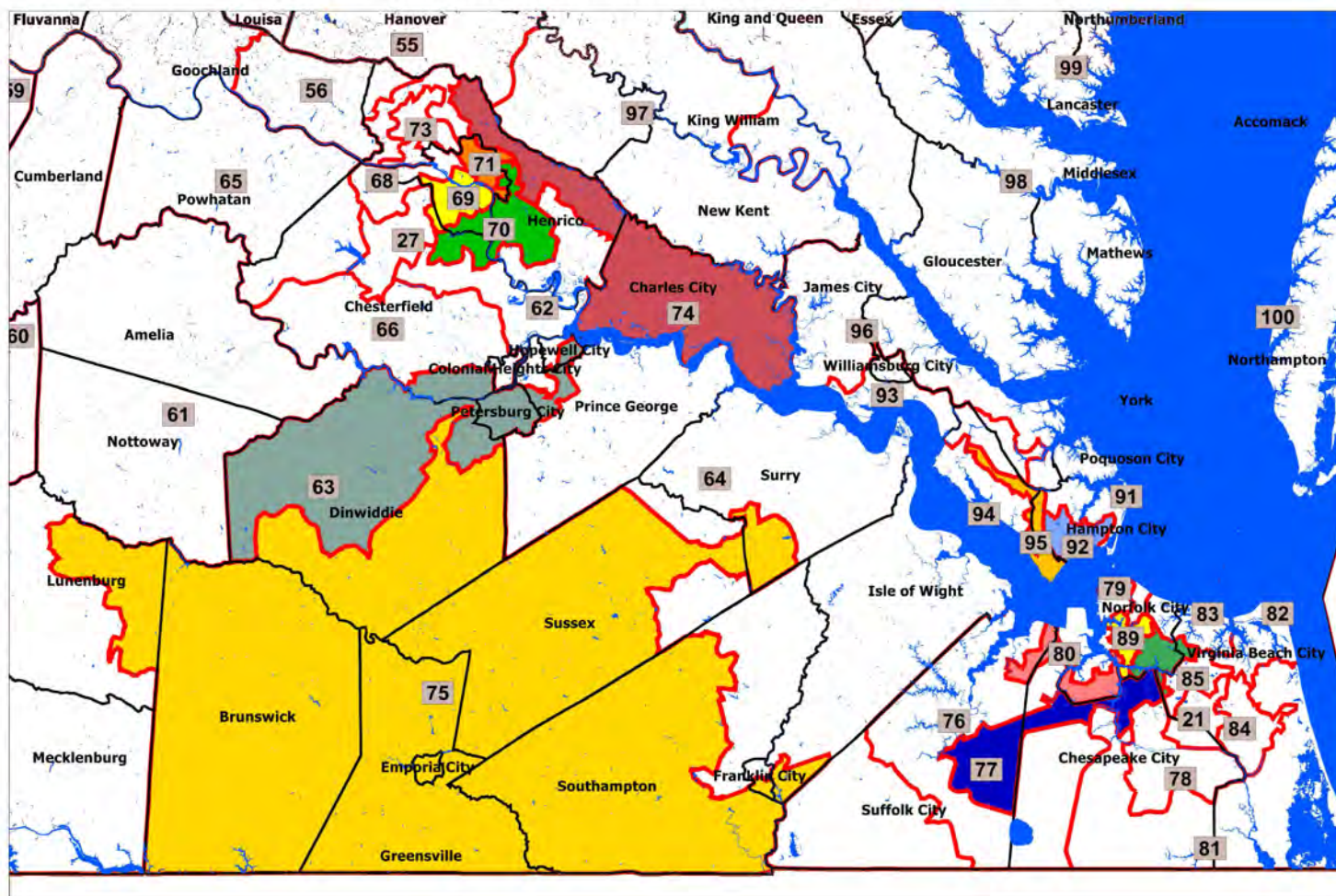


MAP 2

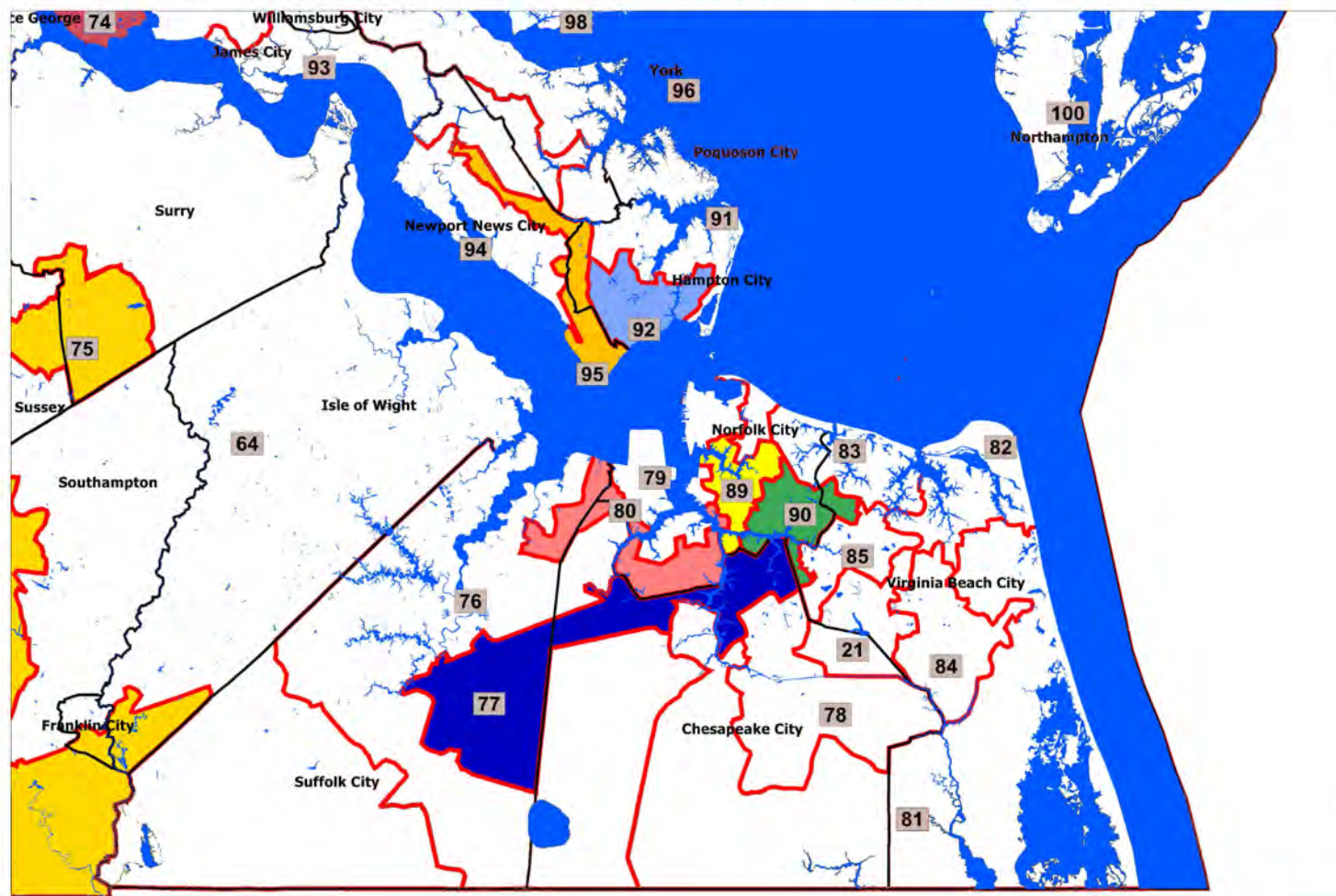
North Carolina Congressional Districts 2001



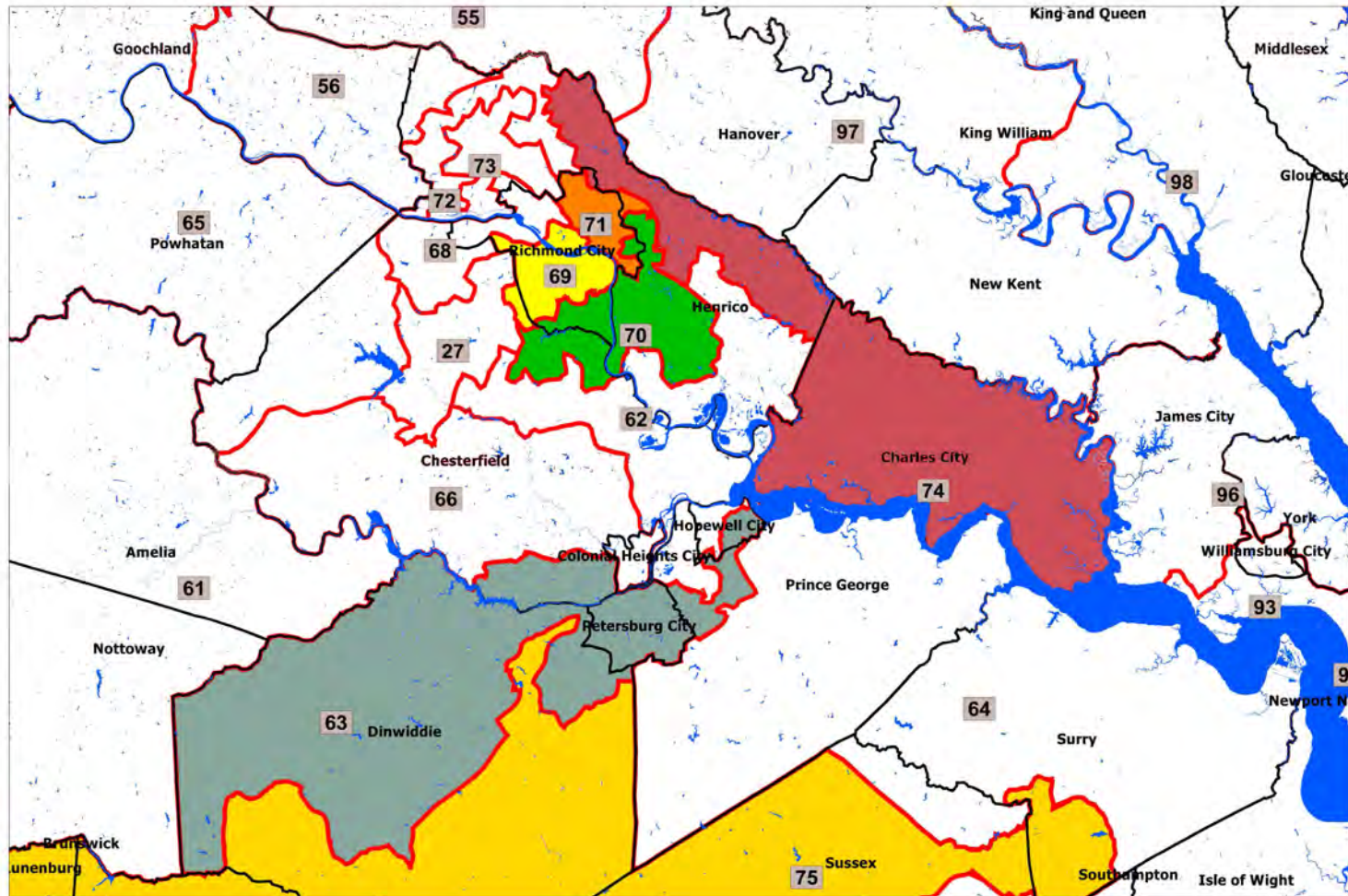
MAP 4
HB 5005 Virginia House Districts (2011)
With 12 Majority African-American Districts Colored



MAP 5
HB 5005 Virginia House Districts (2011)
With 6 Majority African-American Districts in Norfolk Area Colored



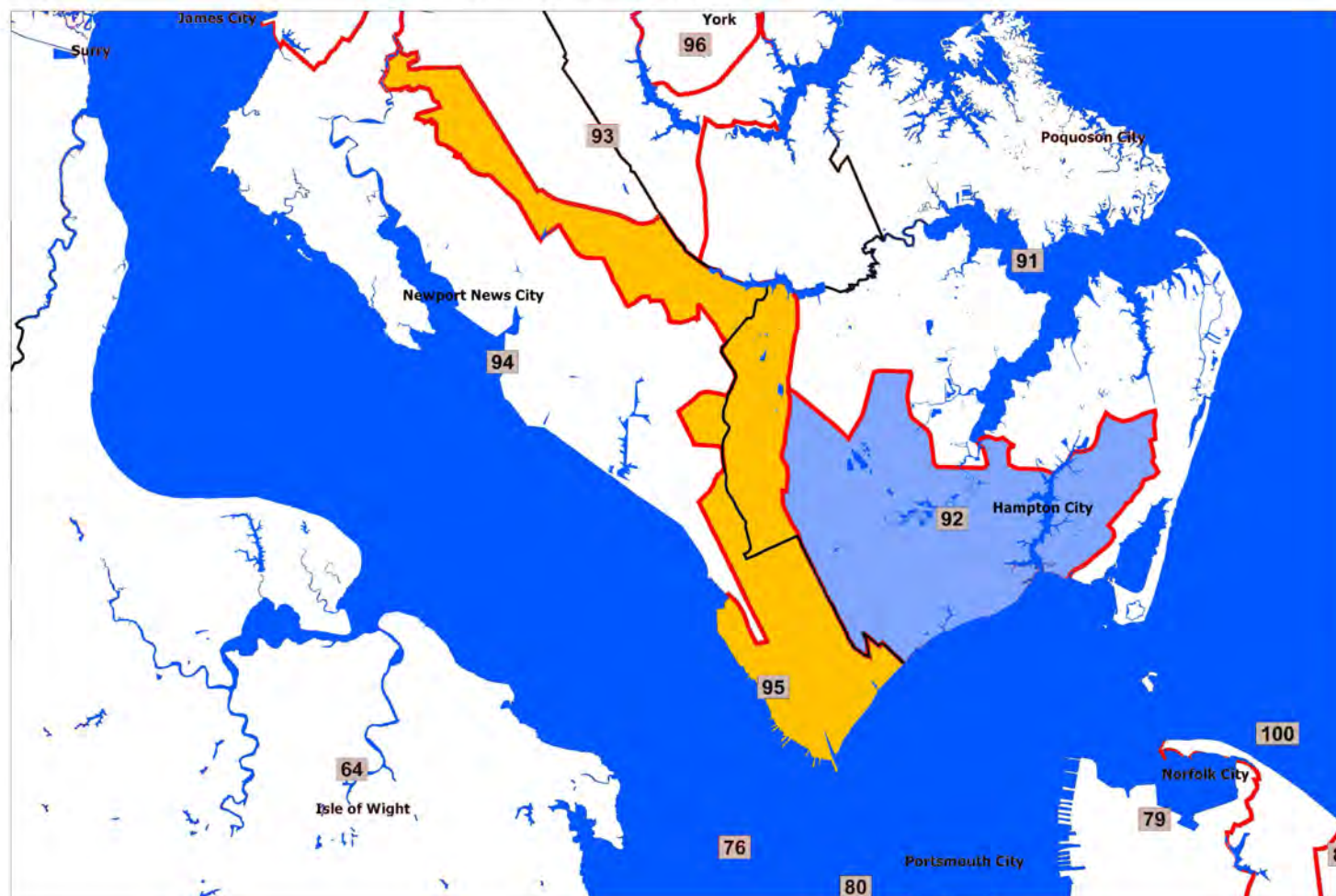
MAP 6
HB 5005 Virginia House Districts (2011)
With 5 Majority African-American Districts in Richmond-Petersburg Area Colored



MAP 7

HB 5005 Virginia House Districts (2011)

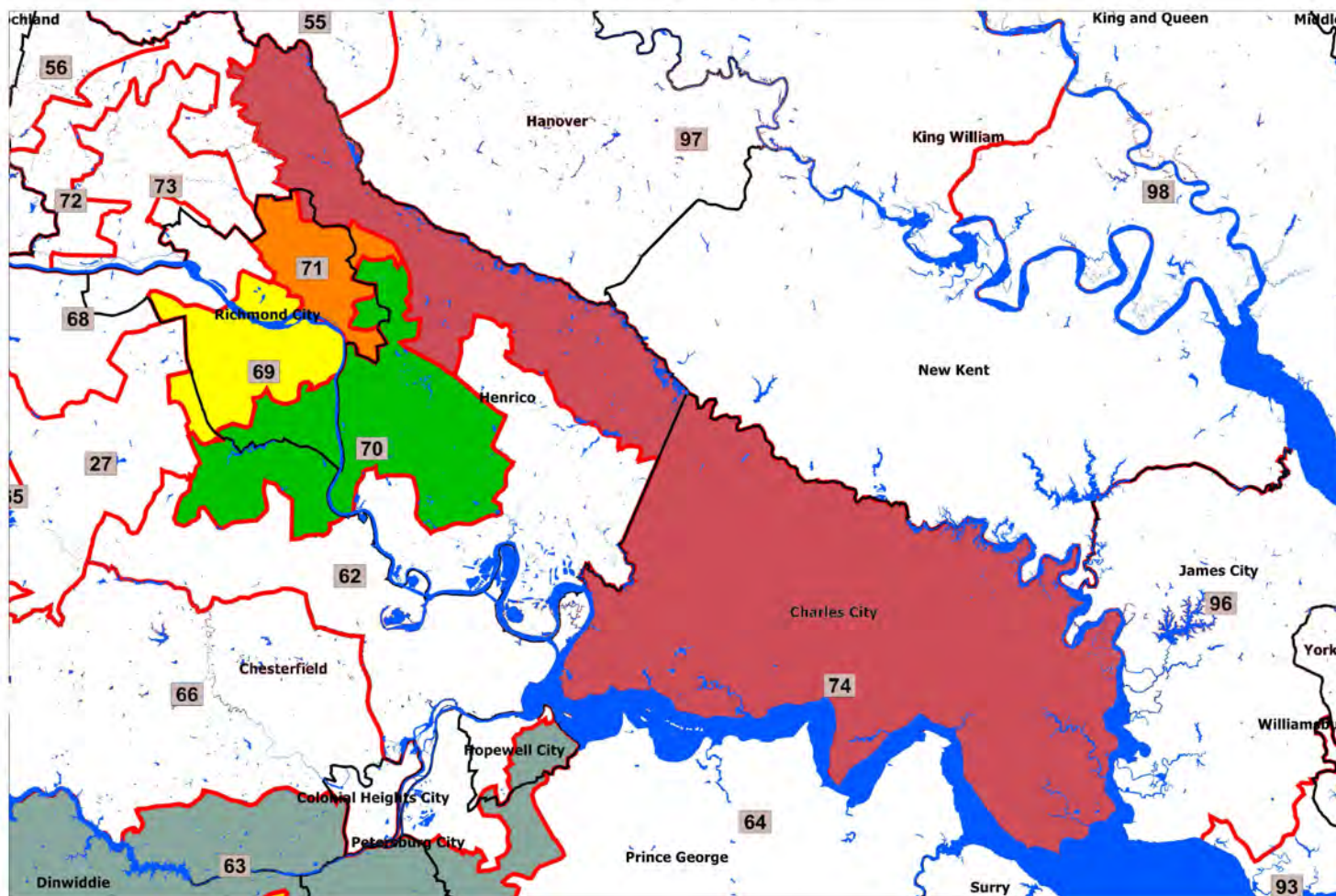
House Districts 92 and 95



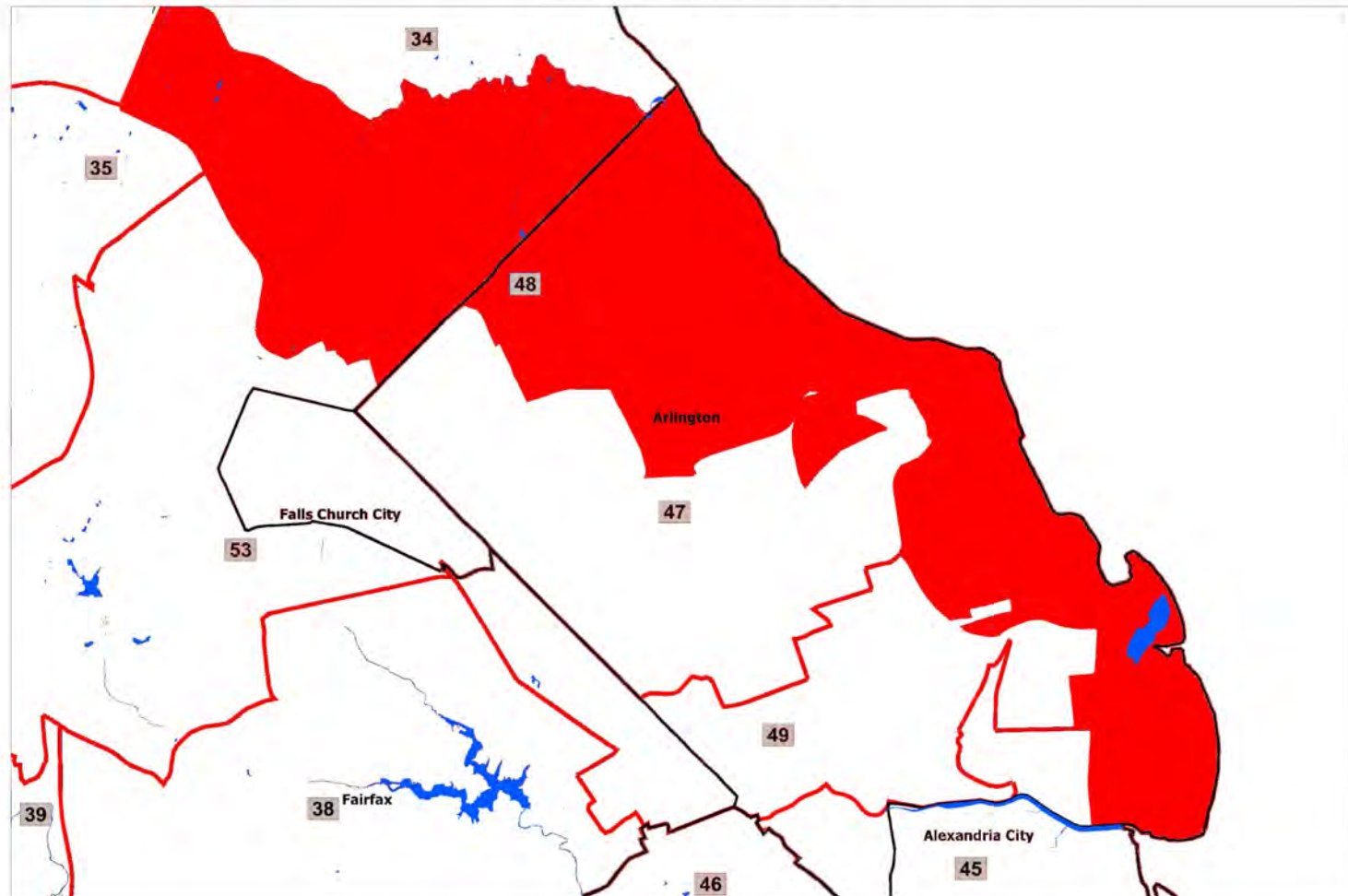
MAP 8

HB 5005 Virginia House Districts (2011)

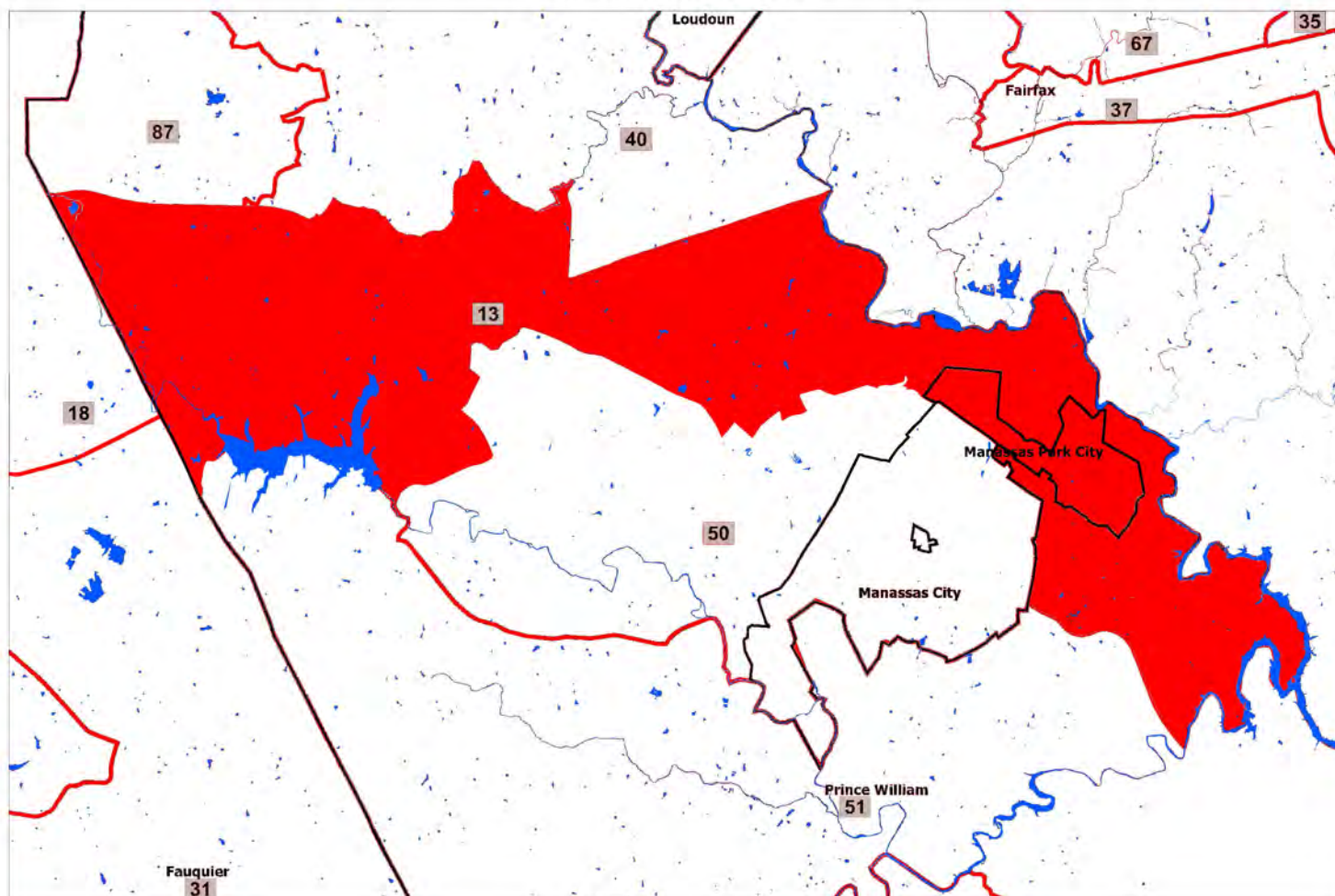
House District 74



MAP 9
HB 5005 Virginia House Districts (2011)
House District 48



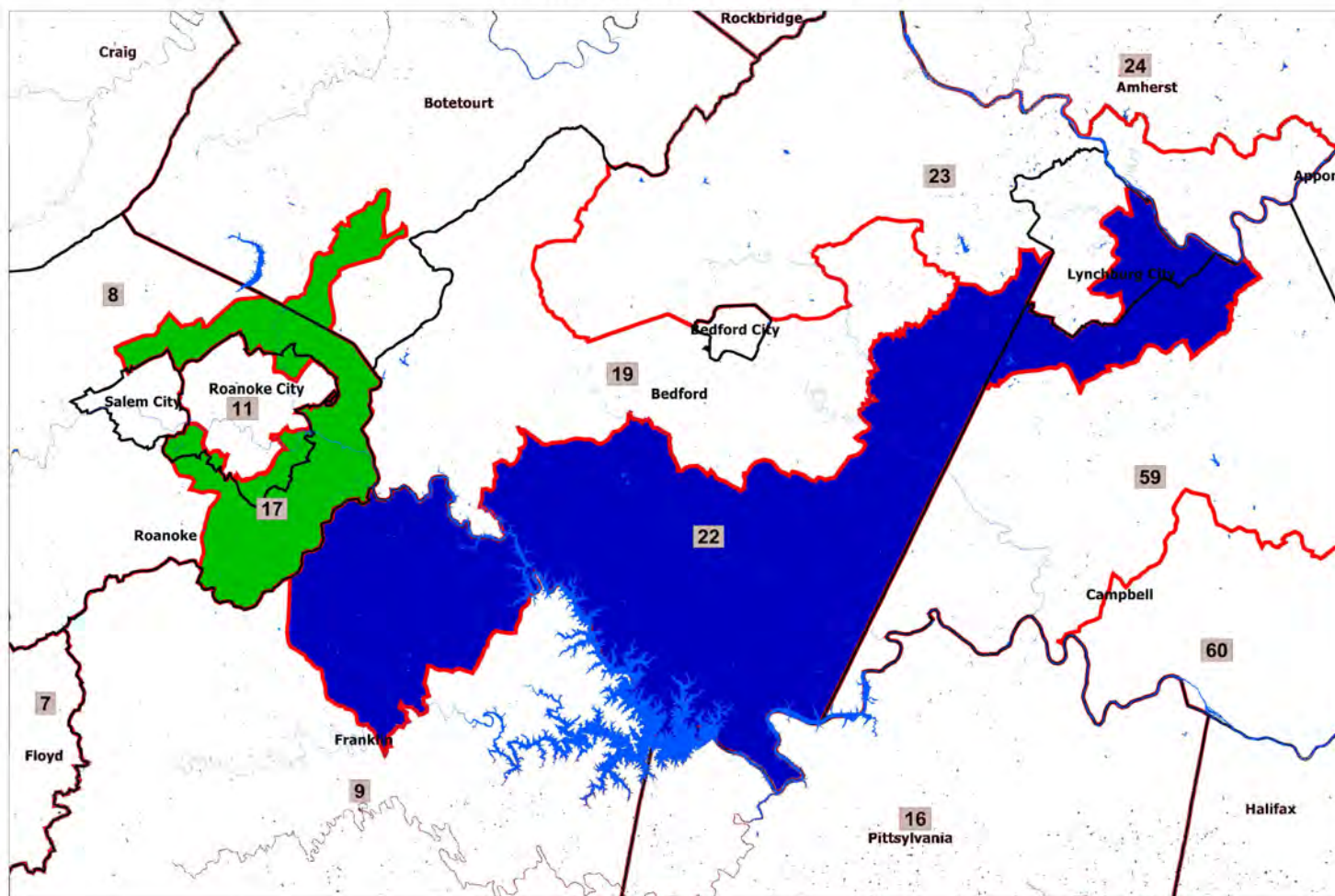
MAP 10
HB 5005 Virginia House Districts (2011)
House District 13



MAP 11

HB 5005 Virginia House Districts (2011)

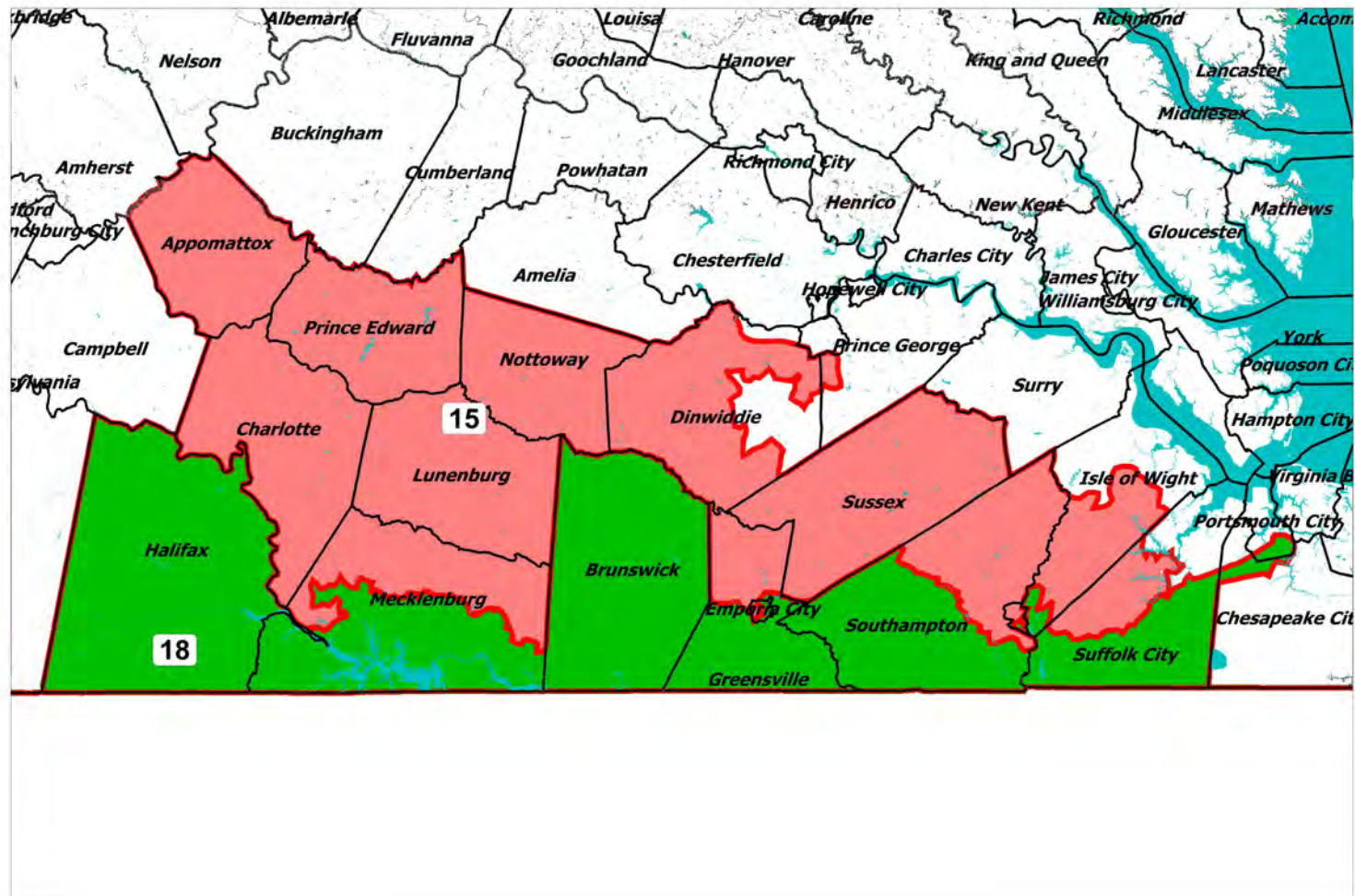
House Districts 17 & 22



MAP 12

1991 State Senate Districts

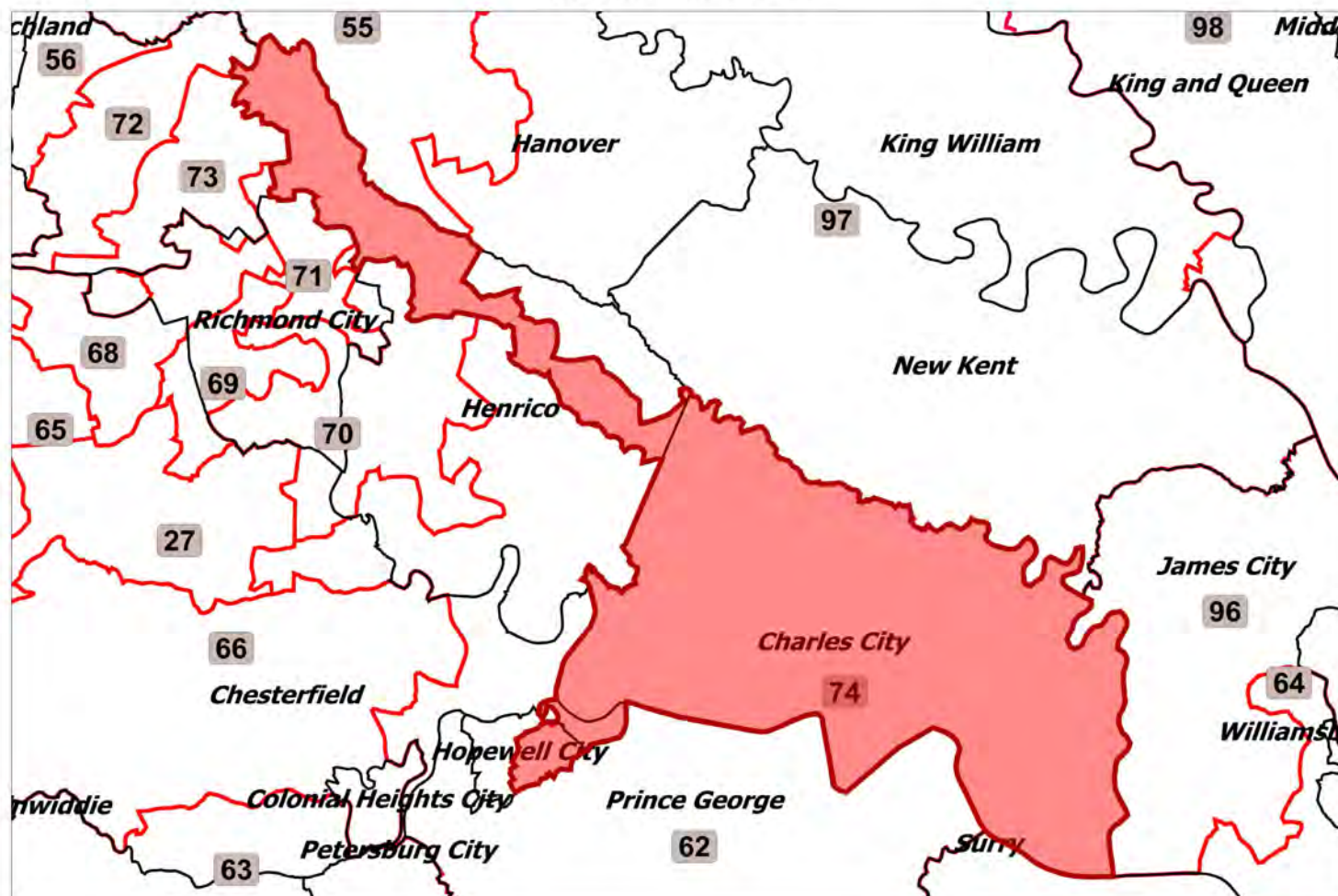
Senate Districts 15 & 18



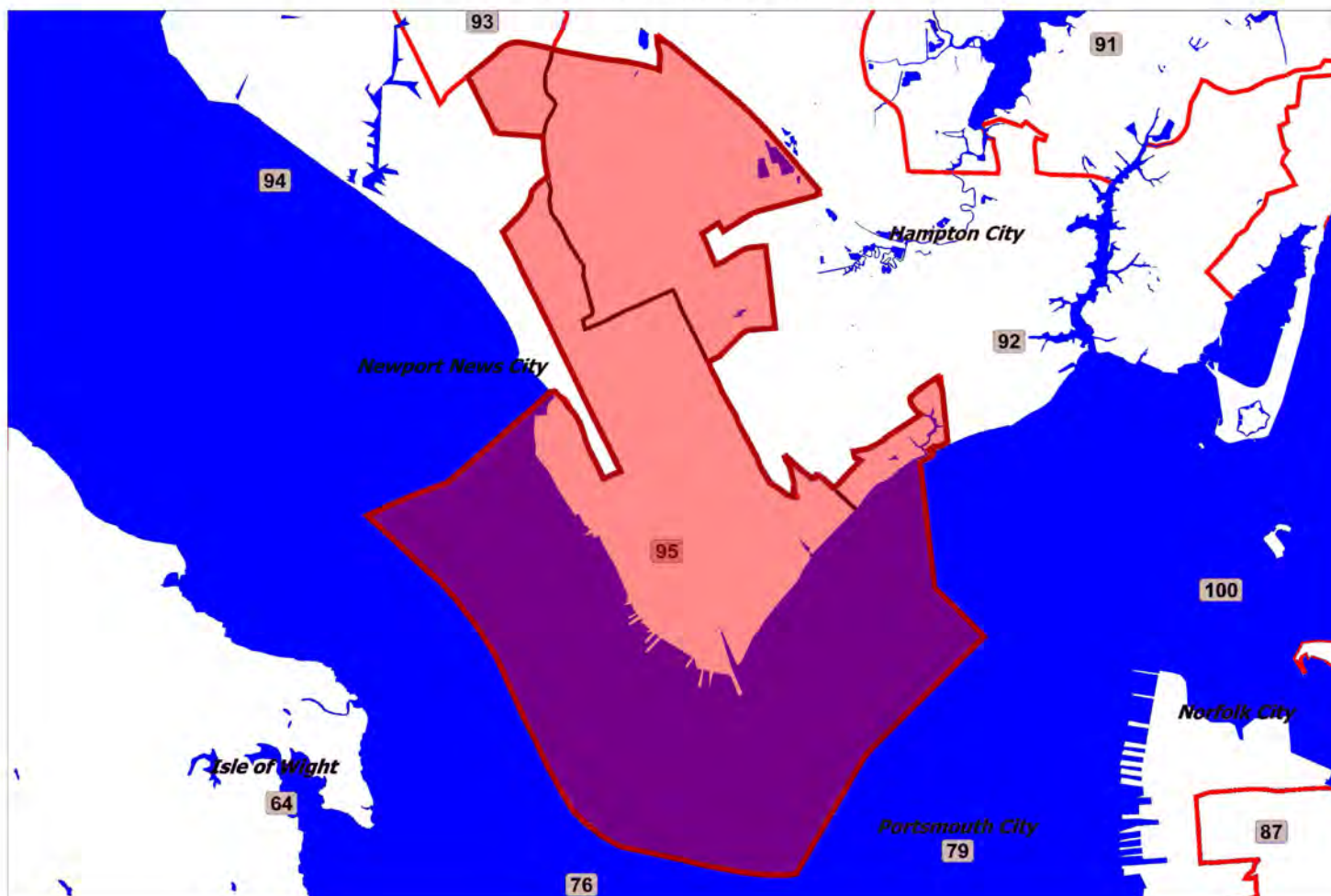
MAP 13

2001 State House Districts

House District 74



MAP 14
2001 State House Districts
House District 95

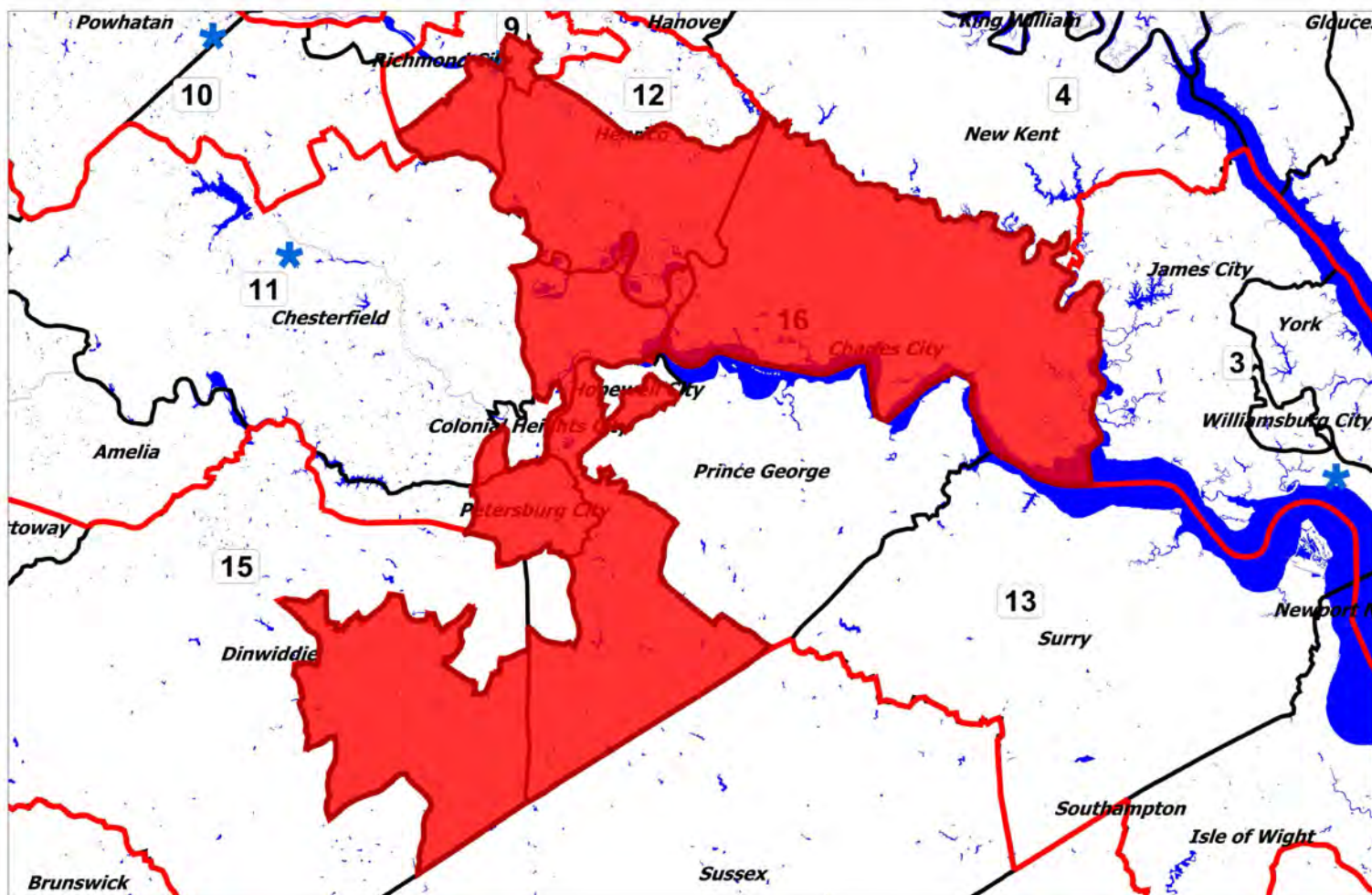


DEFENDANT-INTERVENORS TX 014 - Page 054

DEFENDANT-INTERVENORS TX 102 - Page 179

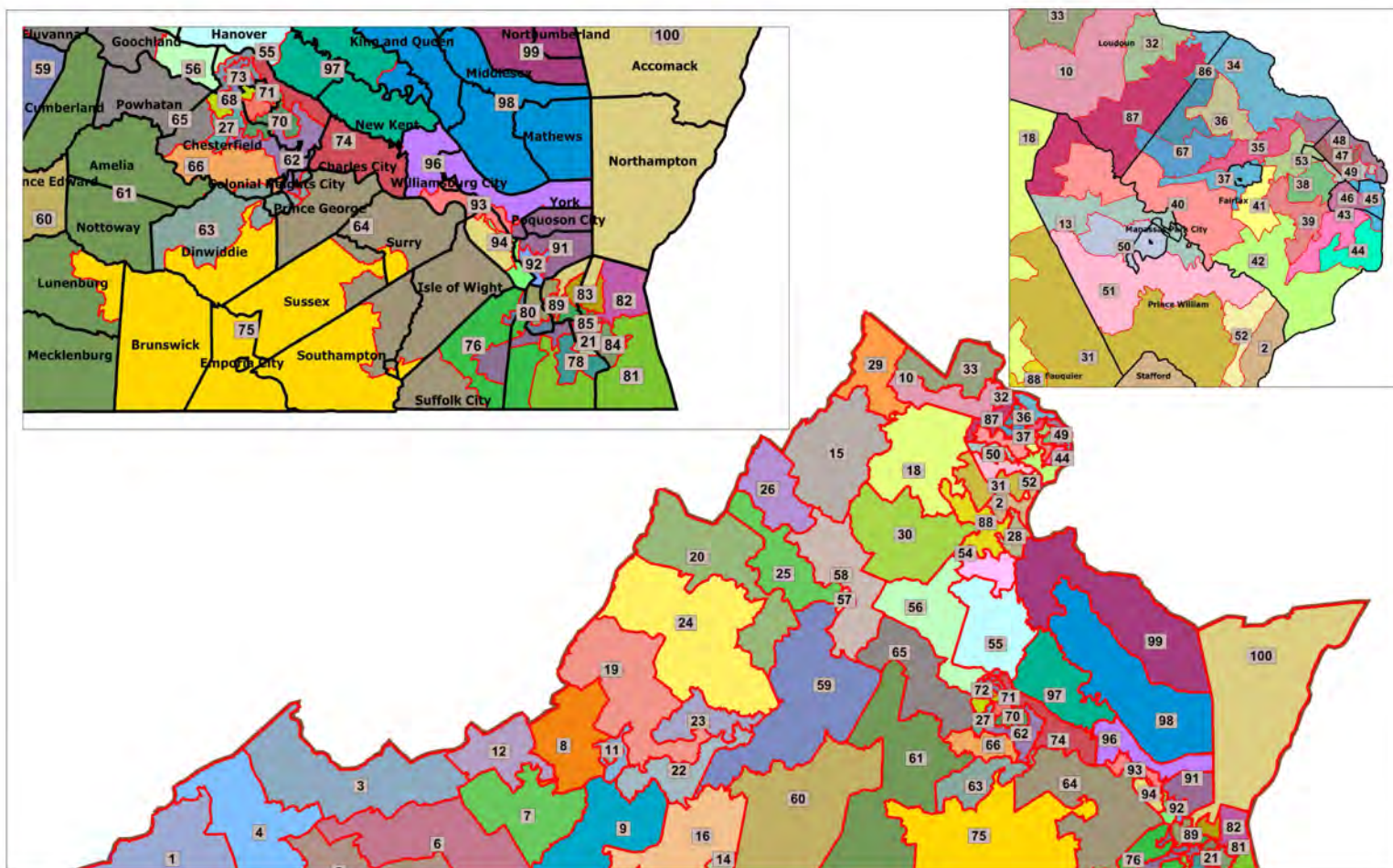
MAP 15

1991 SENATE DISTRICT 16



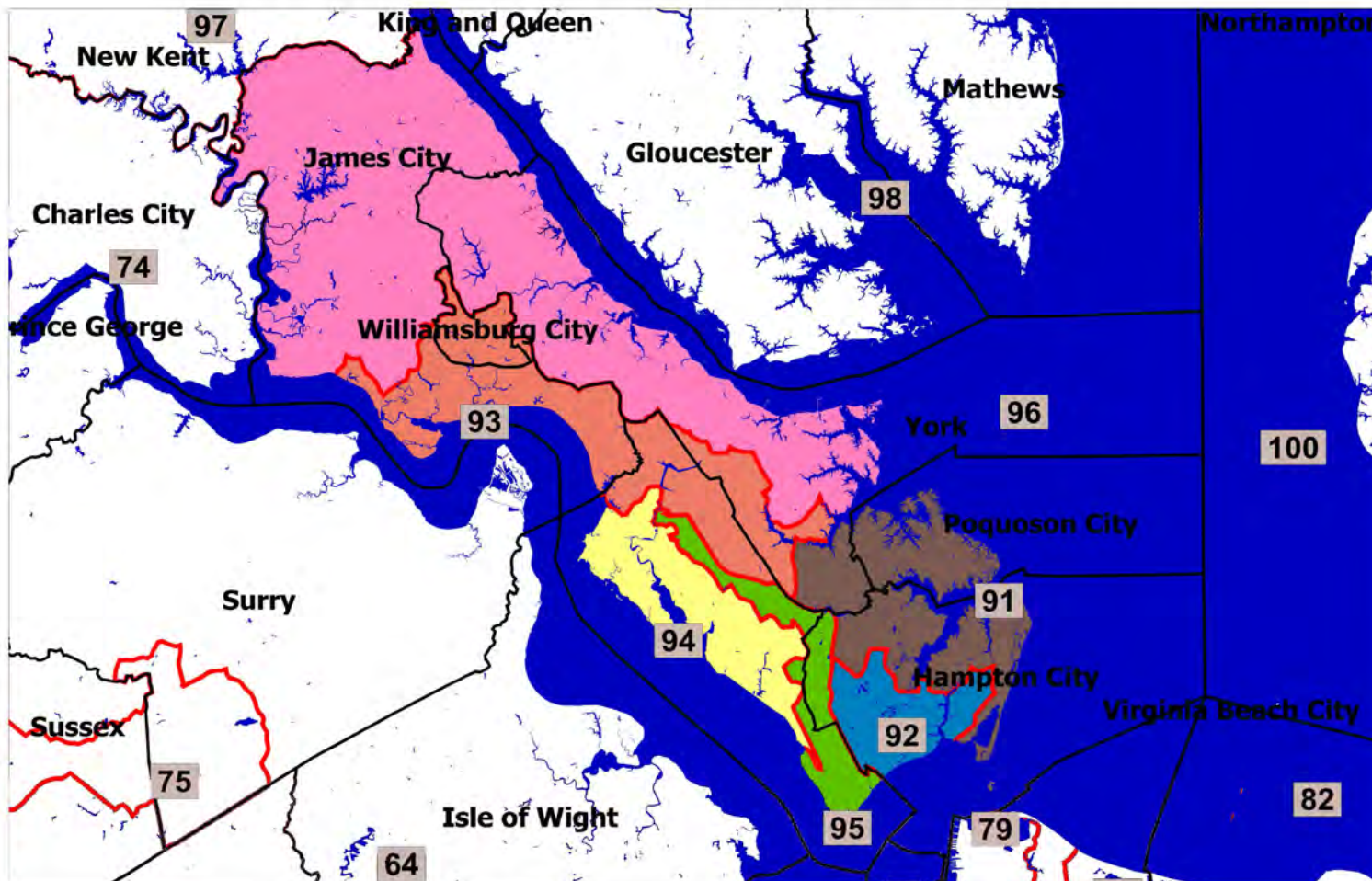
MAP 16

2011 Virginia House Districts - HB 5005



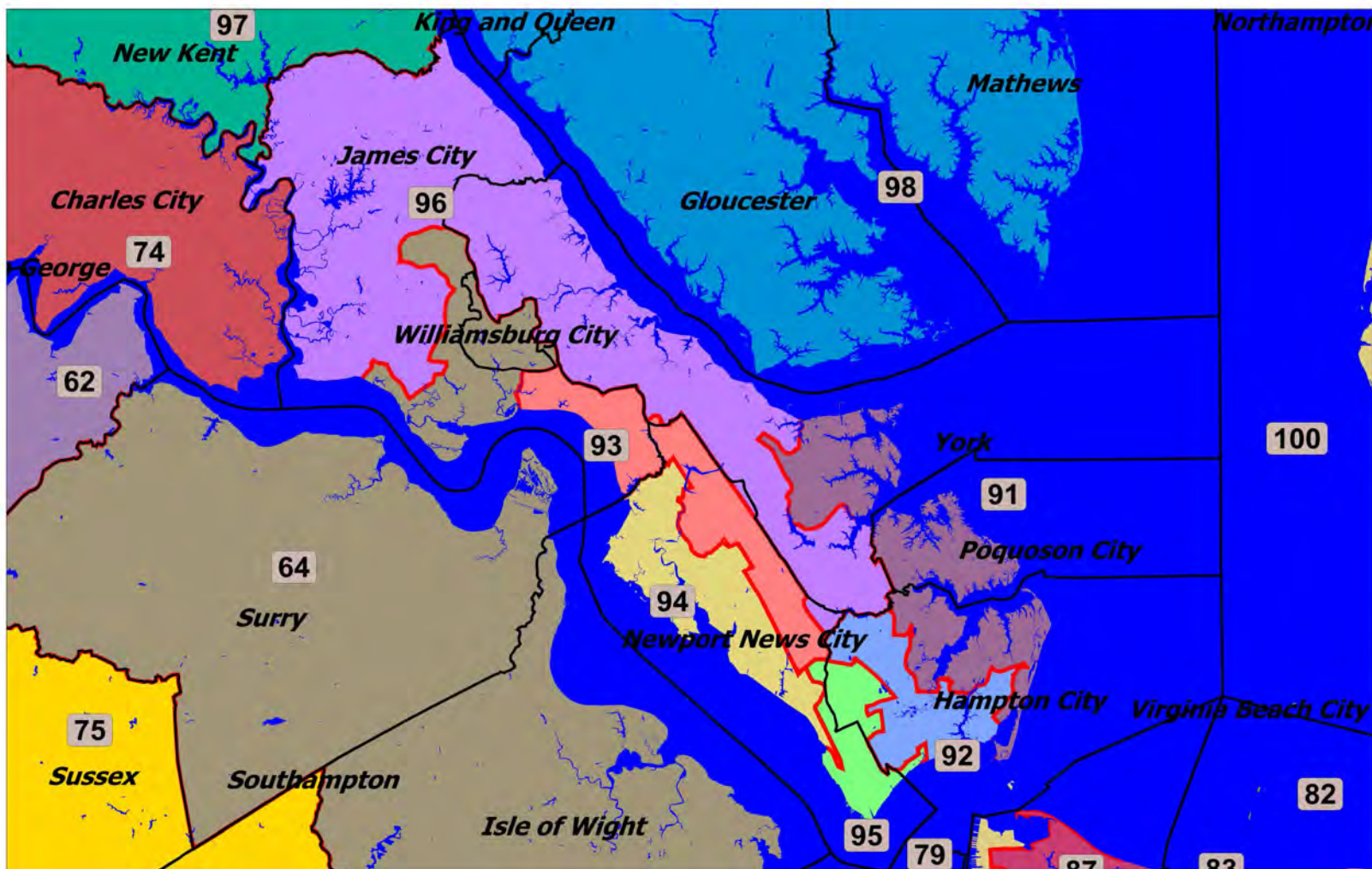
MAP 17

2011 HOUSE DISTRICTS - THE PENINSULA



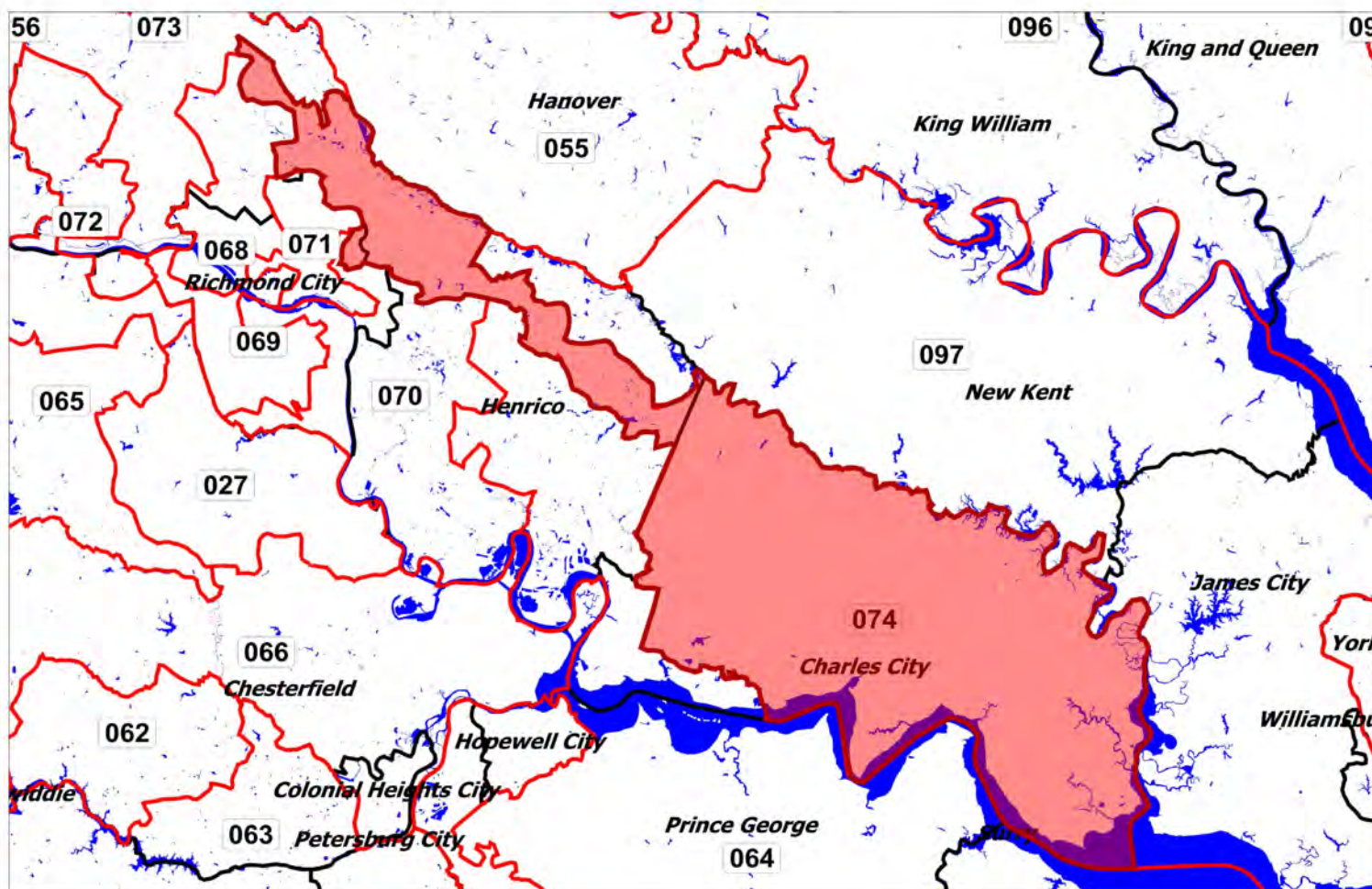
MAP 18

2001 HOUSE DISTRICTS ON "THE PENINSULA"



MAP 19

1991 House of Delegates District 74



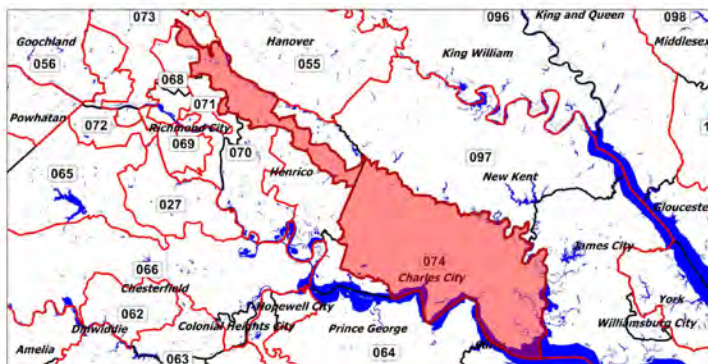
DEFENDANT-INTERVENORS TX 014 - Page 059

DEFENDANT-INTERVENORS TX 102 - Page 184

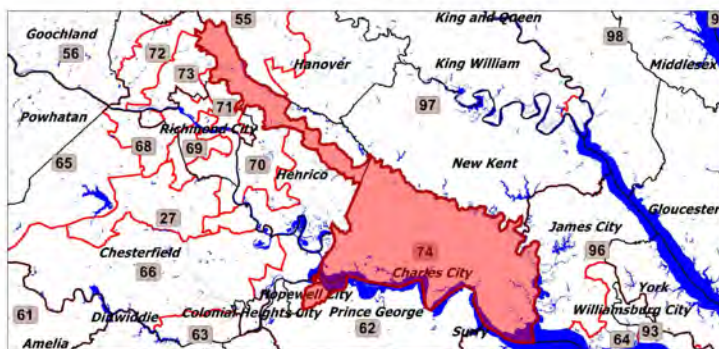
MAP 20

Comparison of House District 74 in 1991, 2001 & 2011

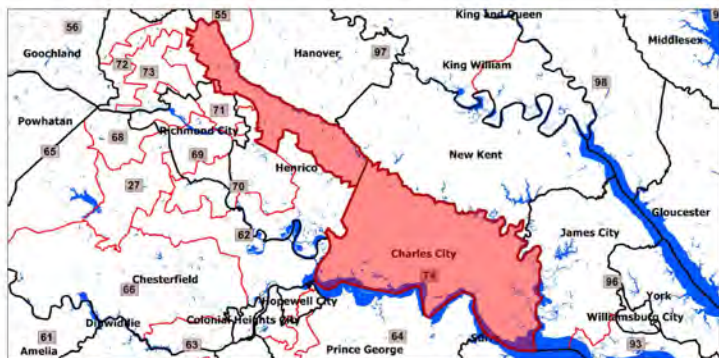
1991



2001



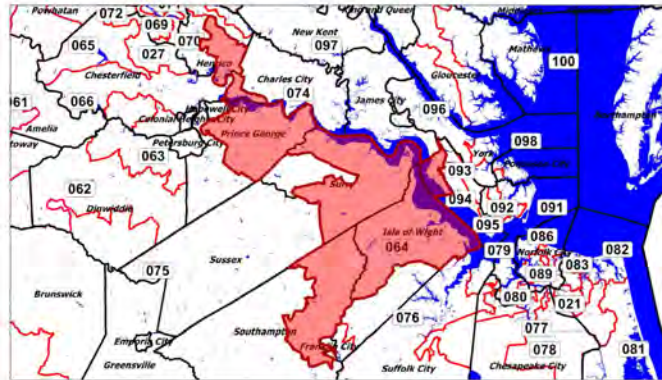
2011



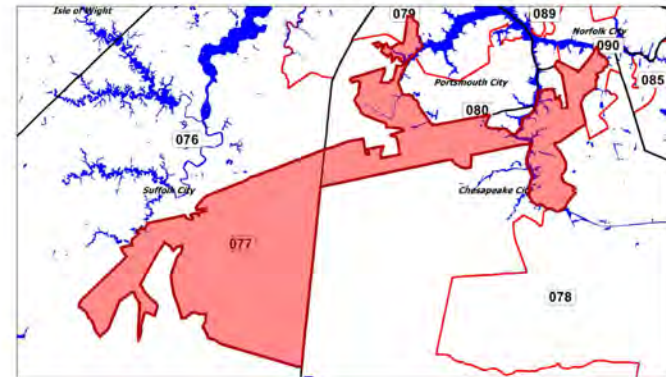
MAP 21

Examples of Non-Compact Districts in 1991 House Plan

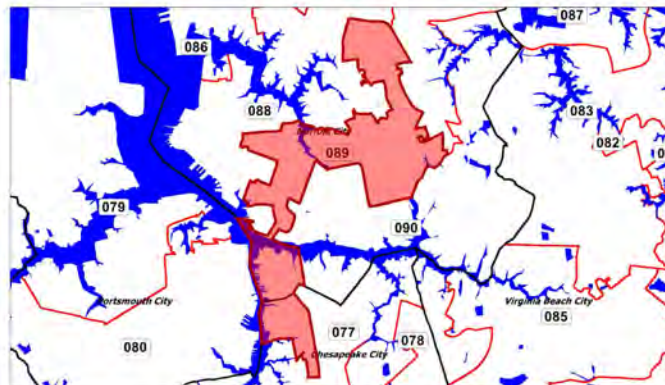
District 64



District 77



District 89



District 98

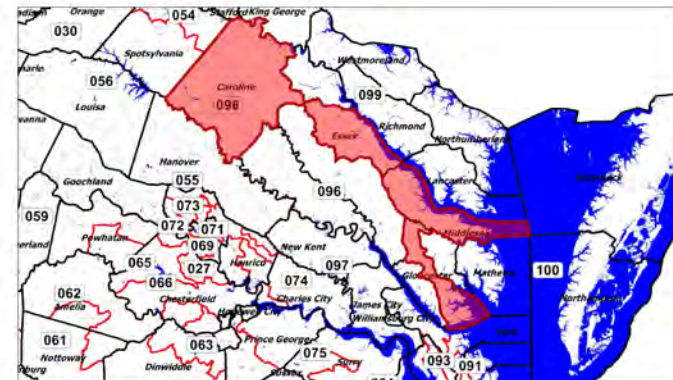


TABLE 1
1991 NORTH CAROLINA CONGRESSIONAL PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.26	0.02
2	0.25	0.05
3	0.37	0.05
4	0.41	0.31
5	0.14	0.07
6	0.45	0.08
7	0.32	0.05
8	0.34	0.14
9	0.28	0.06
10	0.30	0.05
11	0.29	0.12
12	0.05	0.01

Min	0.05	0.01
Max	0.45	0.31
Mean	0.29	0.09
Std. Dev.	0.11	0.08

Scores: North Carolina General Assembly Legislative Services for shape file
United States Bureau of the Census TIGER Line File

Table 1 - Page 1 of 1

TABLE 2
2011 ILLINOIS CONGRESSIONAL PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
01	0.19	0.12
02	0.32	0.36
03	0.28	0.17
04	0.30	0.05
05	0.31	0.09
06	0.31	0.11
07	0.25	0.08
08	0.40	0.12
09	0.24	0.13
10	0.35	0.18
11	0.36	0.12
12	0.31	0.24
13	0.29	0.19
14	0.32	0.17
15	0.32	0.21
16	0.35	0.23
17	0.31	0.19
18	0.49	0.23

Min	0.19	0.05
Max	0.56	0.62
Mean	0.33	0.19
Std. Dev.	0.08	0.13

Source: United States Bureau of the Census TIGER Line File

TABLE 3
VIRGINIA HOUSE AND SENATE COMPACTNESS 1991, 2001 AND 2011
 Showing Reock and Polsby-Popper Scores

State	Reock				Polsby-Popper			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
1991 House	0.14	0.61	0.37	0.11	0.07	0.60	0.25	0.10
2001 House	0.16	0.61	0.38	0.10	0.10	0.58	0.26	0.10
2011 House	0.14	0.62	0.36	0.11	0.08	0.55	0.24	0.09
1991 Senate	0.12	0.63	0.36	0.11	0.09	0.43	0.24	0.10
2001 Senate	0.14	0.54	0.36	0.10	0.13	0.41	0.24	0.08
2011 Senate	0.14	0.46	0.27	0.08	0.08	0.39	0.16	0.06

Source: United States Census Bureau 2010 Redistricting Data TIGER File.

TABLE 4
MULTIPLE STATE LOWER HOUSE PLAN FOR SOUTHERN STATES
Reock and Polsby Popper Compactness Scores Before and After 2010 Census

District Enacted After the 2010 Decennial Census

State	Reock				Polsby-Popper			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
Louisiana	0.11	0.65	0.38	0.11	0.05	0.51	0.26	0.10
Mississippi	0.16	0.61	0.38	0.10	0.07	0.66	0.26	0.12
Alabama	0.11	0.64	0.37	0.10	0.06	0.49	0.21	0.10
Georgia	0.13	0.63	0.39	0.11	0.09	0.54	0.28	0.09
Florida	0.08	0.65	0.43	0.11	0.08	0.68	0.43	0.13
South Carolina	0.11	0.61	0.39	0.09	0.11	0.54	0.28	0.09
North Carolina	0.12	0.57	0.38	0.10	0.04	0.57	0.24	0.11
Maryland	0.16	0.59	0.36	0.10	0.01	0.42	0.18	0.11
Virginia	0.14	0.62	0.36	0.11	0.08	0.55	0.24	0.09

District Enacted Prior to the 2010 Decennial Census

State	Reock				Polsby-Popper			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
Louisiana	0.13	0.62	0.37	0.11	0.06	0.54	0.26	0.10
Mississippi	0.10	0.61	0.34	0.11	0.04	0.59	0.19	0.11
Alabama	0.13	0.61	0.39	0.10	0.07	0.74	0.25	0.12
Georgia	0.19	0.65	0.41	0.11	0.07	0.62	0.29	0.10
Florida	0.14	0.58	0.35	0.11	0.09	0.50	0.24	0.10
South Carolina	0.14	0.61	0.40	0.10	0.13	0.67	0.30	0.10
North Carolina	0.15	0.64	0.41	0.10	0.06	0.64	0.31	0.11
Maryland	0.16	0.59	0.37	0.10	0.01	0.55	0.22	0.13
Virginia	0.16	0.61	0.38	0.10	0.10	0.58	0.26	0.10

Source: U. S. Census Bureau 2010 TIGER line files

TABLE 5
1991 STATE HOUSE PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
001	0.25	0.31
002	0.52	0.38
003	0.51	0.35
004	0.45	0.60
005	0.41	0.29
006	0.57	0.28
007	0.45	0.23
008	0.29	0.18
009	0.25	0.12
010	0.19	0.17
011	0.29	0.15
012	0.58	0.29
013	0.32	0.21
014	0.40	0.15
015	0.36	0.25
016	0.47	0.26
017	0.31	0.09
018	0.41	0.31
019	0.44	0.14
020	0.44	0.24
021	0.25	0.17
022	0.26	0.19
023	0.38	0.22
024	0.35	0.16
025	0.31	0.26
026	0.23	0.18
027	0.40	0.32
028	0.55	0.47
029	0.46	0.33
030	0.60	0.41
031	0.47	0.28
032	0.23	0.19
033	0.50	0.25
034	0.25	0.24
035	0.41	0.18
036	0.47	0.31
037	0.31	0.16
038	0.36	0.28
039	0.44	0.45
040	0.43	0.29

District Number	Reock Score	Polsby-Popper Score
041	0.38	0.34
042	0.38	0.24
043	0.29	0.34
044	0.61	0.41
045	0.31	0.28
046	0.50	0.53
047	0.22	0.24
048	0.26	0.21
049	0.37	0.28
050	0.24	0.15
051	0.36	0.33
052	0.34	0.32
053	0.30	0.23
054	0.39	0.30
055	0.35	0.23
056	0.46	0.35
057	0.48	0.32
058	0.42	0.24
059	0.52	0.29
060	0.61	0.35
061	0.42	0.21
062	0.32	0.07
063	0.46	0.23
064	0.26	0.10
065	0.32	0.25
066	0.22	0.16
067	0.45	0.33
068	0.38	0.26
069	0.29	0.17
070	0.39	0.13
071	0.36	0.19
072	0.34	0.19
073	0.35	0.12
074	0.14	0.11
075	0.39	0.17
076	0.43	0.14
077	0.16	0.08
078	0.46	0.37
079	0.48	0.33
080	0.48	0.34
081	0.49	0.49
082	0.57	0.42
083	0.25	0.19
084	0.37	0.35
085	0.54	0.30

District Number	Reock Score	Polsby-Popper Score
086	0.23	0.36
087	0.32	0.29
088	0.41	0.19
089	0.20	0.09
090	0.25	0.13
091	0.42	0.24
092	0.38	0.20
093	0.17	0.16
094	0.32	0.33
095	0.30	0.30
096	0.19	0.13
097	0.23	0.14
098	0.15	0.09
099	0.24	0.31
100	0.39	0.38

Min	0.14	0.07
Max	0.61	0.60
Mean	0.37	0.25
Std. Dev.	0.11	0.10

Source: U. S. Census Bureau 2010 TIGER line file

TABLE 6
1991 STATE SENATE PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.51	0.22
2	0.21	0.10
3	0.28	0.21
4	0.39	0.29
5	0.30	0.18
6	0.39	0.28
7	0.32	0.21
8	0.35	0.33
9	0.26	0.13
10	0.29	0.19
11	0.38	0.30
12	0.18	0.13
13	0.24	0.18
14	0.49	0.35
15	0.23	0.10
16	0.33	0.09
17	0.38	0.30
18	0.12	0.10
19	0.37	0.43
20	0.46	0.42
21	0.63	0.38
22	0.26	0.17
23	0.47	0.33
24	0.39	0.27
25	0.35	0.29
26	0.27	0.17
27	0.38	0.24
28	0.14	0.13
29	0.34	0.35
30	0.34	0.16
31	0.43	0.31
32	0.48	0.30
33	0.51	0.40
34	0.28	0.20
35	0.49	0.21
36	0.49	0.30
37	0.36	0.18
38	0.38	0.18
39	0.24	0.15
40	0.20	0.17

District Number	Reock Score	Polsby-Popper Score
-----------------	-------------	---------------------

Min	0.12	0.09
Max	0.63	0.43
Mean	0.35	0.24
Std. Dev.	0.11	0.09

Source: U. S. Census Bureau 2010 TIGER line file

TABLE 7
2001 HOUSE OF DELEGATES PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.18	0.22
2	0.36	0.23
3	0.38	0.19
4	0.40	0.29
5	0.43	0.23
6	0.38	0.21
7	0.32	0.16
8	0.52	0.43
9	0.32	0.20
10	0.33	0.20
11	0.49	0.26
12	0.23	0.22
13	0.36	0.15
14	0.18	0.18
15	0.44	0.22
16	0.33	0.12
17	0.23	0.11
18	0.47	0.27
19	0.54	0.22
20	0.47	0.18
21	0.21	0.18
22	0.39	0.20
23	0.38	0.20
24	0.57	0.19
25	0.45	0.24
26	0.52	0.54
27	0.30	0.23
28	0.48	0.28
29	0.45	0.30
30	0.59	0.32
31	0.34	0.14
32	0.35	0.35
33	0.42	0.31
34	0.30	0.25
35	0.38	0.28
36	0.47	0.34
37	0.50	0.35
38	0.52	0.33
39	0.29	0.26

District Number	Reock Score	Polsby-Popper Score
40	0.39	0.29
41	0.44	0.25
42	0.39	0.24
43	0.49	0.58
44	0.36	0.26
45	0.33	0.17
46	0.51	0.40
47	0.34	0.33
48	0.26	0.20
49	0.25	0.19
50	0.47	0.26
51	0.40	0.28
52	0.47	0.33
53	0.44	0.24
54	0.37	0.33
55	0.39	0.25
56	0.41	0.32
57	0.30	0.18
58	0.34	0.15
59	0.59	0.26
60	0.34	0.28
61	0.36	0.15
62	0.34	0.14
63	0.61	0.48
64	0.42	0.19
65	0.48	0.34
66	0.31	0.24
67	0.44	0.26
68	0.35	0.19
69	0.37	0.20
70	0.47	0.14
71	0.24	0.19
72	0.25	0.22
73	0.37	0.18
74	0.16	0.10
75	0.42	0.22
76	0.39	0.18
77	0.18	0.17
78	0.54	0.46
79	0.35	0.22
80	0.39	0.26
81	0.40	0.28
82	0.56	0.57
83	0.31	0.38

District Number	Reock Score	Polsby-Popper Score
84	0.35	0.31
85	0.53	0.43
86	0.34	0.28
87	0.38	0.24
88	0.35	0.16
89	0.58	0.31
90	0.35	0.24
91	0.57	0.40
92	0.28	0.15
93	0.17	0.19
94	0.35	0.40
95	0.43	0.28
96	0.23	0.15
97	0.27	0.11
98	0.25	0.26
99	0.27	0.21
100	0.27	0.35

Min	0.16	0.10
Max	0.61	0.58
Mean	0.38	0.26
Std. Dev.	0.10	0.10

Source: U. S. Census Bureau 2010 TIGER line file

TABLE 8
2001 STATE SENATE PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.41	0.23
2	0.46	0.30
3	0.28	0.17
4	0.31	0.24
5	0.35	0.15
6	0.31	0.31
7	0.29	0.20
8	0.29	0.41
9	0.24	0.14
10	0.54	0.31
11	0.48	0.38
12	0.43	0.34
13	0.42	0.20
14	0.44	0.32
15	0.39	0.19
16	0.36	0.16
17	0.49	0.34
18	0.22	0.13
19	0.41	0.25
20	0.32	0.23
21	0.32	0.18
22	0.24	0.13
23	0.53	0.25
24	0.42	0.23
25	0.23	0.14
26	0.43	0.27
27	0.33	0.19
28	0.16	0.18
29	0.31	0.26
30	0.29	0.19
31	0.51	0.34
32	0.38	0.29
33	0.47	0.39
34	0.46	0.29
35	0.49	0.25
36	0.32	0.20
37	0.26	0.24
38	0.21	0.14
39	0.30	0.20
40	0.14	0.16

District Number	Reock Score	Polsby-Popper Score
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Min	0.14	0.13
Max	0.54	0.41
Mean	0.36	0.24
Std. Dev.	0.10	0.08

Source: U. S. Census Bureau 2010 TIGER line file

TABLE 9
2011 HOUSE OF DELEGATES PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.26	0.30
2	0.30	0.18
3	0.28	0.21
4	0.49	0.20
5	0.19	0.17
6	0.27	0.26
7	0.50	0.25
8	0.47	0.26
9	0.35	0.24
10	0.23	0.18
11	0.59	0.26
12	0.39	0.22
13	0.16	0.13
14	0.24	0.16
15	0.55	0.34
16	0.36	0.18
17	0.25	0.09
18	0.62	0.24
19	0.43	0.17
20	0.27	0.15
21	0.42	0.31
22	0.20	0.11
23	0.26	0.15
24	0.44	0.25
25	0.26	0.18
26	0.46	0.36
27	0.35	0.25
28	0.39	0.26
29	0.36	0.21
30	0.53	0.36
31	0.38	0.19
32	0.46	0.31
33	0.33	0.23
34	0.24	0.22
35	0.20	0.19
36	0.43	0.30
37	0.18	0.18
38	0.62	0.45
39	0.35	0.19
40	0.26	0.17

District Number	Reock Score	Polsby-Popper Score
41	0.36	0.32
42	0.35	0.20
43	0.22	0.21
44	0.43	0.32
45	0.29	0.26
46	0.52	0.55
47	0.41	0.33
48	0.18	0.16
49	0.24	0.16
50	0.46	0.34
51	0.24	0.18
52	0.23	0.25
53	0.46	0.34
54	0.47	0.25
55	0.57	0.28
56	0.34	0.22
57	0.45	0.41
58	0.32	0.19
59	0.30	0.21
60	0.38	0.31
61	0.32	0.17
62	0.36	0.13
63	0.25	0.16
64	0.37	0.16
65	0.37	0.27
66	0.31	0.27
67	0.32	0.25
68	0.36	0.25
69	0.52	0.34
70	0.40	0.19
71	0.33	0.24
72	0.26	0.08
73	0.39	0.15
74	0.16	0.12
75	0.41	0.19
76	0.48	0.17
77	0.19	0.15
78	0.46	0.35
79	0.45	0.26
80	0.26	0.11
81	0.40	0.23
82	0.57	0.45
83	0.52	0.34
84	0.44	0.26

District Number	Reock Score	Polsby-Popper Score
85	0.40	0.24
86	0.35	0.25
87	0.22	0.17
88	0.28	0.13
89	0.40	0.20
90	0.46	0.20
91	0.60	0.47
92	0.34	0.26
93	0.22	0.16
94	0.35	0.38
95	0.14	0.14
96	0.20	0.17
97	0.43	0.21
98	0.28	0.26
99	0.27	0.21
100	0.28	0.37

Min	0.14	0.08
Max	0.62	0.55
Mean	0.36	0.24
Std. Dev.	0.11	0.09

TABLE 10
2011 STATE SENATE PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.16	0.16
2	0.23	0.15
3	0.29	0.11
4	0.33	0.18
5	0.36	0.17
6	0.30	0.30
7	0.32	0.24
8	0.30	0.39
9	0.19	0.11
10	0.30	0.13
11	0.36	0.20
12	0.46	0.23
13	0.31	0.17
14	0.24	0.13
15	0.22	0.13
16	0.31	0.10
17	0.38	0.17
18	0.27	0.14
19	0.30	0.13
20	0.20	0.12
21	0.21	0.14
22	0.35	0.18
23	0.34	0.20
24	0.23	0.15
25	0.30	0.15
26	0.43	0.28
27	0.25	0.20
28	0.15	0.08
29	0.16	0.10
30	0.21	0.10
31	0.17	0.16
32	0.25	0.17
33	0.26	0.15
34	0.31	0.16
35	0.42	0.24
36	0.21	0.09
37	0.18	0.10
38	0.21	0.15
39	0.32	0.20
40	0.14	0.15

District Number	Reock Score	Polsby-Popper Score
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Min	0.14	0.08
Max	0.46	0.39
Mean	0.27	0.17
Std. Dev.	0.08	0.06

Source: U. S. Census Bureau 2010 TIGER line file

TABLE 11
COMPARISON OF CORE CONSTITUENCIES
Comparing Baseline Districts to Enacted Districts
2011 House of Delegates Plan

District	Part of Old District in New	Part of New District from Old	2010 Population Deviation
63	86.59	80.20	-7.86
69	83.17	74.70	-10.89
70	67.31	67.31	-0.79
71	84.78	78.31	-7.27
74	79.52	80.08	0.18
75	88.50	78.64	-11.94
77	77.02	74.40	-3.85
80	68.53	59.94	-11.78
89	82.40	76.86	-7.19
90	71.52	63.21	-11.16
92	86.70	77.27	-11.24
95	73.31	62.15	-15.16
All 12 Dists.	79.11	72.76	-98.95

Source: Maptitude Reports using 2010 Decennial Census Data

TABLE 12
2011 VIRGINIA HOUSE DISTRICTS
Core District Retention Percentages

District	Core Retention Percentage	African-American Majority#	A.A. Core Retention Percentage
1	78.79		
2	-		
3	79.81		
4	21.97		
5	36.06		
6	17.05		
7	52.71		
8	71.76		
9	57.90		
10	-		
11	80.68		
12	51.08		
13	55.98		
14	81.49		
15	81.90		
16	71.47		
17	69.06		
18	59.22		
19	69.15		
20	55.03		
21	68.77		
22	50.33		
23	68.04		
24	75.65		
25	60.19		
26	96.34		
27	48.40		
28	84.12		
29	68.93		
30	95.69		
31	68.56		
32	87.65		
33	74.32		
34	53.98		
35	67.55		
36	77.68		
37	53.62		
38	53.01		
39	58.44		
40	80.42		

District	Core Retention Percentage	African-American Majority#	A.A. Core Retention Percentage
41	69.82		
42	78.87		
43	74.65		
44	86.34		
45	74.03		
46	87.94		
47	80.88		
48	69.20		
49	50.99		
50	58.40		
51	66.09		
52	34.51		
53	76.07		
54	100.00		
55	63.44		
56	93.97		
57	82.49		
58	83.37		
59	61.35		
60	86.10		
61	81.91		
62	56.65		
63	80.20	1	80.20
64	56.20		
65	78.05		
66	87.43		
67	90.57		
68	65.45		
69	74.70	1	74.70
70	67.31	1	67.31
71	78.31	1	78.31
72	51.53		
73	49.89		
74	80.08	1	80.08
75	78.64	1	78.64
76	93.25		
77	74.40	1	74.40
78	94.48		
79	42.35		
80	59.94	1	59.94
81	67.37		
82	71.08		
83	52.01		

District	Core Retention Percentage	African-American Majority#	A.A. Core Retention Percentage
84	75.83		
85	60.22		
86	73.13		
87	-		
88	59.00		
89	76.86	1	76.86
90	63.21	1	63.21
91	61.66		
92	77.27	1	77.27
93	51.43		
94	76.26		
95	62.15	1	62.15
96	65.56		
97	60.95		
98	94.97		
99	100.00		
100	56.91		

Indicated by a "1"

Note: Three Districts should be considered to have been collapsed. They are Districts 2, 10 and 87.

Note: Average core retention for the 100 districts is 67.09%. For the 97 districts which were not collapsed average retention is 69.09%. For the 12 African-American majority districts, average core retention is 72.76%.

Source: Maptitude Reports using 2010 Decennial Census Data

TABLE 13
2001 NORTH CAROLINA CONGRESSIONAL PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.39	0.08
2	0.30	0.07
3	0.41	0.07
4	0.48	0.23
5	0.40	0.23
6	0.38	0.09
7	0.61	0.20
8	0.34	0.21
9	0.34	0.12
10	0.41	0.18
11	0.34	0.25
12	0.12	0.03
13	0.24	0.08

Min	0.12	0.03
Max	0.61	0.25
Mean	0.37	0.14
Std. Dev.	0.12	0.08

Scorces: North Carolina General Assembly Legislative Services for shape file
United States Census Bureau for TIGER line file.

TABLE 14
2011 HOUSE PLAN HB 5005
Comparison of Compactness Scores for 6 Least
Compact Districts

District Number	Reock Score	Polsby-Popper Score	% 18+ AP African-American
13	0.16	0.13	13.66
17	0.25	0.09	6.22
22	0.20	0.11	20.75
48	0.18	0.16	4.88
74	0.16	0.12	57.88
95	0.14	0.14	61.16

Score: U. S. Census Bureau TIGER Line File

APPENDIX 5

An Evaluation of the Geographic Compactness and Contiguity of
Virginia's 2001 House of Delegates and Senate Districts

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INTRODUCTION

I am a Professor of Geography at the University of Alabama, Tuscaloosa, Alabama, where I serve as departmental Chair. I first joined the department in 1989. My formal education includes a BA (1975) in political science from the University of Colorado-Denver, a MS (1980) in geography from Western Washington University, and a Ph.D. (1984) in geography from the University of Kentucky. My primary research and teaching emphases are in political geography on topics ranging from the local to international scales. I have authored or co-authored in excess of 70 publications including over 40 appearing in refereed journal outlets on varied topics including districting. Between 1995 and 1997 I served as Chair of the Political Geography Specialty Group, Association of American Geographers, the largest organization of political geographers in the world. My Vitae accompanies this analysis. A list of court cases for which I have provided testimony is included at the rear of this report.

PURPOSE

The purpose of this report is to evaluate Virginia's 100 state House of Delegates and

40 state Senate districts as delineated in the Enrolled Plans for either chamber in terms of their compliance with the geographic compactness and contiguity criteria. For the purposes of this analysis computer files delineating each district's geographic shape and census geography were downloaded from the Virginia Division of Legislative Services' website by the staff of the University of Alabama Cartographic Research Laboratory. These files included data on the "Enrolled Plan," "Robinson Plan," and "1990s Plan," for the House of Delegates, and for all state Senate districts in the "Enrolled Plan," the "Miller Plan," and the "1990s Plan." Multiple minor errors were identified in all six plans downloaded. These generally involved the misallocation of small blocks. These were corrected with information provided by Mr. Kent Stigall of the state's Legislative Services Section. Additionally, Caliper's Corporation's Virginia data set for use with its "Maptitude for Redistricting" software was purchased. These data were used to calculate the final compactness measures for the districts in all six plans reviewed. These data were also used to test the contiguity of all six plans.

The additional compactness measures for the legislative districts in other states are drawn from the author's files pertaining to other cases or research projects. Compactness measures for the shapes of other jurisdictional entities are included for instructional and comparative purposes. These measures were calculated by the University of Alabama Cartographic Research Laboratory using the Bureau of the Census' TIGER Files.

This report is broken into multiple segments. The first segment below provides a brief summary of the report's findings. The second reviews districting criteria in general, highlighting that the process of delineating districts is oftentimes one of balancing competing and conflicting goals. The third portion of the report reviews the compactness districting

criterion. The fourth segment of the report considers the compactness of Virginia's House of Delegates districts as delineated in the Enrolled Plan, Robinson Plan, and the 1990s Plan. This evaluation also includes a comparison of the geographic compactness of Virginia's 2001 House of Delegates districts as defined in the Enrolled Plan with those in other states. The fifth section of the report examines the compactness of Virginia's state Senate districts as delineated in the Enrolled Plan, Miller Plan, and 1990s Plan. This evaluation also includes a comparison of the Enrolled Plan's Senate districts with those in other states. The sixth section of this report examines the contiguity of the districts in all six plans. The final section of this report reviews my conclusions.

(1) SUMMARY OF OPINIONS

This report finds the 100 House of Delegates districts as delineated in the Enrolled Plan to be sufficiently compact. The Enrolled Plan improves the level of district compactness over the 1990s Plan. The mean level of compactness of the districts defined in the Enrolled Plan also compares favorably with the districts in other Southern states in the 1990s.

This report further finds the 40 state Senate districts as delineated in the Enrolled Plan to be sufficiently compact. The Senate Enrolled Plan equals or exceeds the level of compactness in the 1990s Plan. The Enrolled Senate Plan also compares adequately with other Southern Senates on the measures of compactness calculated.

Finally, this report finds that both the House and Senate Enrolled plans delineated contiguous districts.

(2) DISTRICTING CRITERIA

Districting plans may be evaluated from the perspective of a number of goals or criteria including population equality, racial equity, geographic compactness, incumbent protection and limiting the division of local government subdivisions, among others (see for example, Morrill 1981, 1982, 1987, 1994; Dixon 1982; Grofman 1985, 1993; Grofman et al., 1992; Butler and Cain 1992). While the equality of population and racial equity criteria emanate from the United States Constitution, all other criteria have had either historically variable or no legal mandate (Morrill 1981; Grofman 1985). For example, while federal law required that congressional districts be compact from 1901 to 1929, no such federal statutory mandates exist at present (O'Rourke 1997: 62).

Several states have varying requirements about the geographic design of legislative districts including Virginia (Grofman 1985: 177-183). Article II of Section 6 of the Constitution of Virginia states that

Members . . . of the Senate and of the House of Delegates of the General Assembly shall be elected from electoral districts established by the General Assembly. Every electoral district shall be composed of contiguous and compact territory and shall be so constituted as to give, as nearly practicable, representation in proportion to the population of the district.

As is the circumstance with most such provisions in state constitutions, the Constitution of Virginia provides little guidance for the interpretation of this requirement as it relates to compactness. But in *Jamerson v. Womack* (1992: 508), a decision pertaining to Virginia's 1990s state legislative districts, the court stated that

While the Districts are not ideal in terms of compactness, proper deference must be given to the wide discretion accorded to the General Assembly in the value of the relative degree of compactness

required when reconciling the multiple concerns of apportionment

We may therefore conclude that the Virginia 1990s districts were judged constitutionally acceptable and that the General Assembly has significant discretion in meeting this constitutional obligation. Additionally, we might conclude that at minimum, if the levels of compactness of post-*Jamerson* Virginia State Assembly plans are equal to or above the levels existing in the plans litigated in the 1990s, subsequent plans have met or exceeded the General Assembly's obligation to delineate geographically compact districts.

It is important to state that real-world circumstances limit the degree to which multiple districting goals can be simultaneously achieved (Morrill 1987; Butler and Cain 1992). As a practical matter those delineating districts face the task of balancing multiple and oftentimes contradictory goals including those mandated by the Voting Rights Act and implicit in the Equal Protection Clause (see Justice O'Connor's concurring statement in *Vera v. Bush* 1996; Webster 1997). In such decisions the primary constitutional necessities of achieving population equality and racial equity must receive preeminent emphasis. At times this emphasis may lead to lesser levels of success in meeting secondary or subsidiary districting goals. Thus, to comply with the equal population criterion the geographic compactness of a district in an area with a spatially discontinuous or geographically dispersed population may be of a lesser objective level than a district delineated around an evenly distributed population. Likewise, to achieve compliance with the increasingly stringent one-person-one vote mandate, those delineating districts may be required to subdivide counties and other local government units (Butler and Cain 1992: 84).

In other cases efforts to comply with the Voting Rights Act's Section 2 prohibition

against vote dilution may also lead districters to draw district lines which do not maximize compliance with subsidiary districting goals including, among others, compactness and limiting the subdivision of local government units. In such circumstances the Supreme Court's three-pronged test for vote dilution as contained in their 1986 *Gingles* decision provides guidance. As stated in the opinion (pp. 50-51):

First, the minority must be . . . sufficiently large and geographically compact to constitute a majority of a single-member district Second, the minority group must be . . . politically cohesive Third, . . . the white majority votes sufficiently as a bloc to enable it . . . usually to defeat the minority's preferred candidate.

If evidence for all three prongs is established, the creation of a majority-minority district is warranted if not mandated. Under such conditions, deviations from the stringent application of traditional districting criteria such as compactness and population equality may be appropriate and/or necessary. Such an emphasis does not void the necessity of paying heed to other criteria including geographic contiguity, compactness or communities of interest, but rather may provide the basis for justifying deviations (Grofman et al., 1992: 61-81).

At times, even in the absence of a racially diverse population, the delineation of representational units may benefit from a relaxation of stringent adherence to some subsidiary districting criteria. For example, the boundaries of local government units (e.g., counties, municipalities) are historical features and may encircle multiple and highly contrasting communities of interest within their areal extents. This being so, map makers may view as positive the conscious subdivision of some local governments in an effort to provide

representation to contrasting economic or demographic groups. For example, providing different units of representation for an inner city area and its surrounding suburbs allows the opinions of potentially very different populations to be better represented. Alternatively, including an agglomeration of lower income neighborhoods in a single district may facilitate their political participation to a greater degree than the submersion of these neighborhoods into districts dominated by upper income suburbs. Such conscious divisions can provide more equitable access by varied populations to the political system, and are therefore valuable to protect and improve the integrity of democratic processes.

Subsidiary districting goals also frequently conflict with one another. In these circumstances judgments about which criteria to emphasize must be made. Butler and Cain (1992: 86), for example, write that "Since compactness is rarely a consideration in [municipal] annexation proceedings, districts that follow city lines will also be non-compact." Thus, if compactness is emphasized in the delineation of districts, municipal boundaries may be crossed by the boundaries of representational units. Local jurisdictional boundaries may also be crossed as a result of the constitutionally mandated racial equity criterion. As stated by Butler and Cain (1992: 87), "A districting plan that dilutes minority voting strength by refusing to cross city or county boundaries may be in violation of the VRA." This point is also made by Richard Morrill (1987: 248), and Bruce Cain (1984: 71).

As noted above, the boundaries of local government units may encircle widely contrasting demographic groups in terms of economic pursuits, social interactions, and political outlooks. Effective elected representation may become increasingly difficult if widely diverse demographic groups are geographically lumped in the same district. Equitable and effective representation may therefore be improved by subdividing diverse

populations within the same local government unit. Hence, an emphasis upon creating comparatively homogeneous districts may lead to the subdivision of local government units if not lesser degrees of objective geographic compactness. Again, this is not to suggest that any particular criterion should be entirely neglected. Rather all districting decisions are the result of balancing the goals of competing if not contradictory criteria.

(3) GEOGRAPHIC COMPACTNESS CRITERION

Unlike the equality of population criterion, the geographic compactness criterion has no current foundation in the U.S. Constitution (Niemi et al., 1990; Pildes and Niemi 1993: 527-529). In spite of its limited current constitutional mandate, district compactness has long been viewed as a criterion for evaluating districting plans. It is further a central element in the first prong of the *Gingles* test for minority vote dilution. District compactness is also included as a goal for legislative districts in approximately half of all state constitutions though almost exclusively in qualitative or general terms (Pildes and Niemi 1993: 529-530). As noted above, the state of Virginia is among those states requiring that the members of legislative bodies be elected from compact districts (Grofman 1985: 177).

Given recent Supreme Court decisions largely pertaining to congressional districts in North Carolina, Georgia and Texas, the compactness criterion has received renewed attention in the legal and academic literature (e.g., Grofman 1993; Horn et al., 1993; Pildes and Niemi 1993). Of central importance in the elevation of district compactness as a districting goal is the Court's decision in *Shaw v. Reno* (1993) which "isolates district appearance and turns it into a threshold factor for setting strict scrutiny into motion" (Pildes and Niemi 1993: 539). Thus while irregularly shaped districts are not illegal or unconstitutional in and of

themselves, they may provide one basis for triggering judicial investigations into the processes which created the districts.

There is substantial legal and academic disagreement over the value of mandating districts be compact (Dixon 1968: 458, 522-534; Taylor and Johnson 1979; Niemi et al., 1990). As stated by prominent political geographer Richard Morrill (1981: 22), "A too simplistic application of such geometric compactness measures is foolish" First, requiring compact districts does not necessarily guard against the political or racial manipulation of electoral space. The geographic resolution and quality of the population data now provided by the census in conjunction with the increasing sophistication of computer technology, may allow comparatively compact districts to be delineated which are intended as discriminatory. Thus, while irregularly shaped districts may suggest manipulation, highly compact districts may also be intentionally detrimental to a population group (see Morrill 1981; Grofman 1985; Niemi et al., 1990).

Second, in the real-world, perfectly compact districts are an impossibility. Most compactness measures assume that an optimal district will be a perfect circle, the most compact of geometric shapes (e.g., Reock 1961). But if circles were employed to subdivide the space of a jurisdiction some of the jurisdiction's area would not be allocated to districts, but be left in the gaps between circles. Thus, circular districts are an unrealistic abstraction with limited application to real-world circumstances.

Third, the building blocks of redistricting plans, blocks, block groups, tracts, or election precincts, are frequently delineated by streets or natural features which result in non-compact shapes. As stated by one observer, attempting to construct compact districts from non-compact building blocks such as counties or census tracts is "a lot like trying to build a

level wall out of a pile of different sized rocks" (as quoted in Orr 1970: 72). The spatial design of these building blocks therefore precludes circular districts from being formed.

At the opposite geographic scale, the boundaries of the political subdivisions being districted (e.g., a state, county or municipality) also circumscribe the level of potential district compactness. Districts which follow irregular state or county boundary segments such as meandering rivers or embayed coastlines may be of relatively low objective or statistical compactness. Thus, comparisons of districts between states or between geographically differentiated areas in the same state must be made with caution and attention to local circumstances.

Fifth, satisfactorily meeting other criteria such as the population equality criterion may limit the level of district compactness. It is of substantially greater legal necessity to comply with the equal population criterion than to create highly compact districts. To reiterate, the districting process is one of balancing goals which frequently conflict with one another.

Sixth, it should be made clear that compactness is not an absolute but rather a comparative quality of a districting plan since not even a theoretical districting plan can be entirely composed of perfectly circular districts. We cannot therefore easily conclude that one plan is composed of compact districts while another is not. Minimal differences between the levels of compactness in one plan versus another should not be employed to claim one plan is superior to the other. As stated by Pildes and Niemi (1993: 563, note 223),

Just as there is no bright line between compact and noncompact districts, there is no one number that determines whether the difference between compactness scores is significant. Clearly, a small difference - for example, .01 - is not meaningful

Finally, there exists a host of different measures by which district compactness may be measured (Niemi et al., 1990). The methods of calculating compactness used here are drawn from a 1993 Michigan Law Review article by Richard Pildes (Professor of Law, University of Michigan) and Richard Niemi (Professor of Political Science, University of Rochester). Both authors are recognized authorities on redistricting and the courts in the United States. The purpose of their article was to measure the compactness of the congressional districts existing in 1993 in such a manner as to parallel the discussion in the Supreme Court's decision in *Shaw v. Reno* (1993). Adding to the relevance of this article and its methods was its citation in *Bush v. Vera* (1996) as supporting evidence for the Supreme Court's findings that three congressional districts in Texas were unconstitutional.

The two measures of compactness employed in this report, both recommended by Pildes and Niemi (1993), were calculated for all 100 Virginia House of Delegates districts in the "Enrolled," "Robinson," and "1990s Plans, and for all 40 state Senate districts in the "Enrolled," "Miller," and "1990s Plans." The first measure is based on the geographic "dispersion" of the district. Conceptually this measure evaluates the level of spatial concentration of a district's geographic extent. To calculate this measure the smallest possible circle is circumscribed around a district. The reported coefficient is the proportion of the area of the circumscribed circle which is also included in the district and ranges from 1.0 (most compact) to 0.0 (least compact). To avoid confusion, it is important to note that the geographic dispersion compactness measure is sometimes referred to as the "Reock Test" or "Reock Measure" after its primary early proponent, Earnest C. Reock (1961).

The second measure is based upon the calculation of the "perimeter" a district. Conceptually it evaluates the length of the district's perimeter relative to the amount of area

included within the district. The reported coefficient is the proportion of the area in the district relative to a circle with the same perimeter. The coefficient also ranges from 1.0 (most compact) to 0.0 (least compact). This measure may be traced to a 1927 article by Cox (Niemi et al., 1990: 1161), and has recently been referred to as the "Polsby-Popper Measure" due to their support for its application (Polsby and Popper 1991).

Compactness Calculations: Hypothetical and Real World Examples

It is generally rare to find real-world jurisdictions having substantial levels of geographic compactness. To demonstrate this point and the application of the two measures of compactness employed in this report, compactness coefficients are presented for a square, a rectangle, the state of Virginia, the city of Newport News, Lee County, King William County, and three voting precincts or "VTDs" (Figures 1-9). Visually, squares are generally evaluated as being highly compact. But the geographic dispersion measure for the square in Figure 1 is far below a "perfect" 1.00 at 0.636. Similarly its perimeter compactness coefficient is 0.785. When calculated for the rectangle in Figure 2 the geographic dispersion coefficient falls to 0.381 and the perimeter measure to 0.589.

Figures 3-9 provide "real-world" Virginia examples of the application of both compactness measures. For example, the state of Virginia is presented in Figure 3 and has a geographic dispersion compactness coefficient of 0.229, but a lesser score of 0.163 on the perimeter compactness measure. Map makers will arguably find creating highly compact districts in irregularly shaped states like Virginia more difficult than in more geometrically compact states such as Colorado, all things being equal (Polsby and Popper 1991: 351). The compactness of the city of Newport News is presented in Figure 4. Notably, while its

dispersion compactness (0.219) is fairly similar to the state of Virginia's, its perimeter compactness (0.307) is substantially greater. This comparison underscores that the two compactness measures employed here emphasize different aspects of geographic compactness and do not necessarily vary from jurisdiction to jurisdiction in highly similar manners. Figures 5 and 6 present the compactness of Lee County and King William County. Clearly Lee County's level of geographic dispersion compactness (0.204) is in part constrained by its geographic location in the western "toe" of Virginia (Figure 5). In contrast, its large proportion of straight line boundaries keeps its level of perimeter compactness (0.352) comparatively high. King William County's (Figure 6) level of compactness is constrained by its meandering boundary which substantially decreases its level of perimeter compactness (0.159) when compared to Lee County. Finally, and as noted above, the shapes of the building block units used to delineate representational districts can limit their objective compactness. Figures 7-9 present the shapes of three different voting precincts. All three are intended to illustrate the difficulties a map maker faces when attempting to build highly compact districts from irregularly shaped building blocks. Their geographic dispersion compactness coefficients range from 0.093 to 0.203, and their perimeter compactness coefficients range from 0.144 to 0.255.

The above examples should underscore that the two compactness indicators emphasize different geographic dimensions and should be used in tandem given their contrasts. It is quite possible that the compactness coefficient for one of the two indicators is relatively quite large when compared to the other. Secondly, the above examples also underscore that compactness coefficients below 0.200 or 0.100 are not uncommon, most particularly for the perimeter measure. Pildes and Niemi (1993: 563), for example, reported that in 1993, 13%

of all congressional districts in the United States had perimeter measures less than 0.100.

Evaluating Compactness Measure Coefficients

There are no strict scales or “bright lines” to judge compact and noncompact districts using the two compactness measures used in this report. The lack of a strict standard reflects the reality that compactness indicators cannot be evaluated without attention to both the legal context under which the districting process is occurring and local geographic conditions. We cannot, therefore, simply conclude that a coefficient of 0.100 qualifies as a low level of compactness without considering the circumstances under which the district was delineated. Underscoring this point is the fact that many county boundaries follow the irregular courses of rivers. If a district boundary follows a county boundary which follows the course of a meandering river, its perimeter may be significantly extended. Under these circumstances the district's perimeter compactness measure may be low when compared to a district of the same areal size but with straight line boundaries.

With attention to the above noted caveats, Pildes and Niemi (1993: 565) provide guidance to evaluate the two measures used in this report. With substantial attention paid to the Court's language in *Shaw*, they suggest cutoff levels for “low” compactness on both the dispersion and perimeter indicators. With respect to the dispersion compactness measure, they suggest “low” is equal to or less than 0.150. On the perimeter compactness measure they suggest that “low” is equal to or less than 0.050. With respect to this guidance, they state that “In choosing the cutoff points used . . . [here], . . . we do not imply that all districts below those points, or only those districts, are vulnerable after *Shaw*” (Pildes and Niemi 1993: 564).

But it is true that those 1992 congressional districts successfully challenged in North Carolina (12th) and Texas (18th, 29th, and 30th) were below these cutoffs on one if not both of the compactness measures used here. They were also used to affirmatively determine the constitutionality of the four Alabama legislative districts challenged in *Rice v. Bennett* in late 1997. Finally, they were also used by a three-judge panel in *Cromartie v. Hunt* to analyze Congressional Districts 1 and 12 in North Carolina's 1997 congressional districting plan. Most notably in this regard is the Supreme Court's decision in April 2001 in the *Cromartie* litigation which found constitutional the spatial configuration of the 12th Congressional District as delineated in 1997, but not used until 2000. The 12th Congressional district's geographic dispersion compactness coefficient was 0.109 and its perimeter compactness coefficient was 0.041. While it would be improper to assume all districts above these levels are prima facie constitutional, the decision does provide general support for the relevance of the low compactness cutoff points as suggested by Pildes and Niemi (1993). This is most particularly the case if a district characterized by comparatively low geographic compactness was delineated for partisan or incumbent protection purposes.

A final set of questions to be addressed pertain to the appropriateness of applying these two compactness indicators and their suggested benchmarks for "low" compactness to districts at different scales (e.g., congressional, state legislative, city council districts). Because both measures are ratios they are completely appropriate for application to any geographic scale of districts, whether congressional, state legislative or city council districts.

Whether the benchmarks for "low" compactness are equally applicable to districts at different geographic scales may be in part dependent on the specific characteristics of the units in question. For example, Pildes and Niemi (1993: 559) suggest the contrasting levels

of adherence to the one-person-one-vote standard can impact the resulting levels of compactness. In general, population equality between congressional districts is required at levels substantially less than 1.0%. In contrast, in most states legislative districts may legally have total population deviations up to 10% (Grofman et al., 1992: 110-111; Pildes and Niemi 1993: 559). This less restrictive parameter may provide greater flexibility in the geographic delineation of legislative districts. The potential for this greater flexibility is largely non-existent in Virginia due to its much stricter requirement that district populations not vary by more than "plus-or-minus two percent."

More pertinent from a geographic as well as a practical perspective is the number of potential building blocks for the delineation of districts at different scales. The number of potential building blocks, be they census blocks, census tracts or election precincts, will constrain the levels of geographic compactness of smaller scale units to a greater degree than larger scale units. To define a congressional district the map maker may have thousands of blocks or hundreds of precincts from which to converge on an acceptable solution. In contrast, lower level units (e.g., legislative or city council districts) will have a far smaller number, perhaps dozens, of potential building block units for inclusion to converge on an acceptable solution.

Because these building block units can vary widely in their respective populations and geographic shape, even a somewhat less stringent population equality standard of $\pm 2.0\%$ (as compared to $\pm 1.0\%$ for congressional districts) may be an obstacle to simultaneously creating highly compact districts. Thus, nationally the greater flexibility provided by a less stringent population equity requirement for state legislative districts can be largely negated by a reduced number of potential building block geographic units. This practical limitation is

particularly pertinent to Virginia due to its stricter population equality requirement. Therefore, in my opinion the Pildes and Niemi suggested cut off points for low compactness may be applied to lower scale geographic districts as well as congressional districts.

(4) COMPACTNESS OF VIRGINIA'S HOUSE OF DELEGATES DISTRICTS

Both compactness measures were assembled in tabular format for all of Virginia's 100 House of Delegates districts in the Enrolled Plan, in the Robinson Plan, and for the 1990s Plan (Tables 1-3). Table 1 presents both compactness indicators in the order of the House of Delegates district numbers. Table 2 orders all 100 House of Delegates districts in terms of increasing coefficient magnitude on the perimeter compactness measure for all three of the plans. Table 3 lists all House of Delegates districts in terms of increasing coefficient magnitude on the geographic dispersion compactness measure for all three plans. The three plans are also presented in map form in Figures 10-12.

The average value for all 100 Virginia House of Delegates districts in the Enrolled Plan on the perimeter compactness measure was 0.26 (Table 1). This was virtually identical to the mean on the perimeter measure in the 1990s Plan (0.26), though slightly less than for the Robinson Plan (0.28).

No district in any of the three plans had a perimeter compactness coefficient below the suggested 0.05 benchmark for low compactness (Table 2). But the 1990s Plan did include the lowest coefficients on this measure of any of the three plans. For example, four House of Delegates districts in the 1990s Plan (districts 62, 77, 89, and 98) had perimeter compactness coefficients below 0.10, while no district in either the Enrolled Plan or the Robinson Plan had a single district below 0.10 on the perimeter compactness measure. In

contrast, the lowest perimeter compactness coefficient for the Enrolled Plan was for district 74 at 0.10. In the Robinson Plan the least compact district was 77 at 0.13.

In summary with regard to the perimeter compactness measure, none of the three plans included a single district with a coefficient below the suggested cut off level for low compactness. In spite of this finding, the 1990s Plan did have multiple districts of lesser levels of perimeter compactness when compared to the Enrolled or Robinson Plans. The Enrolled Plan and the Robinson Plan differ only minimally in their mean levels of perimeter compactness. The mean for the Robinson Plan is 0.02 larger than for the Enrolled Plan, a difference that is negligible.

The mean level of dispersion compactness for the Enrolled Plan's 100 House of Delegates districts was 0.38. This was marginally above the mean for the 1990s Plan of 0.37, and marginally below the mean for the Robinson Plan of 0.39. The difference in means between the Enrolled and Robinson plans was extremely negligible at 0.01. Both plans should therefore be judged as virtually identical in terms of their mean levels of geographic dispersion compactness.

As stated above, all three plans are largely comparable with respect to their means on the geographic dispersion compactness measure. But the 1990s plan had one district with geographic dispersion compactness coefficient below the suggested cut off level of 0.15 for low compactness (Table 3). This district, number 74, had a geographic dispersion compactness coefficient of 0.14. In contrast, the Enrolled Plan's lowest coefficient was for District 74 at 0.16. The Robinson Plan's lowest coefficient was also for District 74 at an identical 0.16.

In summary, the three plans were largely similar in their mean levels of perimeter and

geographic dispersion compactness. But while the Enrolled and Robinson Plans had no districts below the suggested cut off points for low compactness, the 1990s Plan had one district with a low level of compactness on the geographic dispersion measure (District 74). When comparing the Enrolled and Robinson Plans directly, they are judged very similar in terms of both compactness measures.

District Compactness for Virginia's House of Delegates Districts in Comparison to the Lower Chambers of Other Southern State Legislatures

Table 4 presents the average or mean compactness for all state House districts in Alabama, South Carolina, Georgia, Louisiana, North Carolina and Virginia in the 1990s so that they may be compared with the Enrolled Plan. This comparison is undertaken to provide a context for the Enrolled Plan's mean level of perimeter and geographic dispersion compactness. The means for other states in the 1990s are used because they are the most current available. Alabama, for example, has only recently passed a new state House districting plan and is now awaiting a preclearance decision from the Department of Justice.

The Enrolled Plan's House of Delegates districts compare favorably with those in other states (Table 4). While its mean level of geographic dispersion compactness of 0.38 is below Georgia's mean of 0.39, it is above that for South Carolina (0.36), Louisiana (0.37), and Virginia in the 1990s (0.37), and virtually identical to Alabama (0.38) and North Carolina (0.38). Similarly, the Enrolled Plan's perimeter compactness mean of 0.26 is below Georgia's (0.29), but above the means for Alabama (0.25), South Carolina (0.24), and North Carolina (0.25). And the Enrolled Plan's perimeter compactness mean is virtually identical to the mean for the 1990s plans in Virginia (0.26) and Louisiana (0.26).

5) COMPACTNESS OF VIRGINIA'S STATE SENATE DISTRICTS

Both compactness measures were assembled in tabular format for all of Virginia's 40 state Senate districts in the "Enrolled Plan," the "Miller Plan," and the "1990s Plan." Table 5 presents both compactness indicators in order of their state Senate district numbers. Table 6 orders all 40 state Senate districts in terms of increasing coefficient magnitude on the perimeter compactness measure for all three of the plans. Table 7 orders all 40 state Senate districts in terms of increasing coefficient magnitude on the geographic dispersion compactness measure for all three of the plans. The three plans are also presented cartographically in Figures 13-15.

The average value for all 40 Virginia state Senate districts in the Enrolled Plan on the perimeter measure was 0.24 (Table 5). This was virtually identical to the mean on the perimeter measure in the 1990s Plan (0.24), though slightly less than for the Miller Plan (0.26). The total range of the means was 0.02, indicating all three plans are quite similar in terms of their average levels of perimeter compactness.

As discussed above, 0.05 may be considered "low" on the perimeter compactness measure. None of the three plans had a single district with a perimeter compactness score below this level (Table 6). But the 1990s Plan did have two districts below 0.10 including the 16th (0.09) and 2nd (0.09). While the Enrolled Plan had no district below 0.10 on the perimeter compactness measure, District 16 in the Miller Plan had a coefficient of 0.09. The lowest score on the perimeter compactness measure in the Enrolled Plan was for District 18 at 0.12. Notably, four districts in the 1990s Plan (districts 16, 2, 15, 18) and three districts in the Miller Plan (16, 5, 12) were less compact on the perimeter measure than the least compact district in the Enrolled Plan (District 18 at 0.12).

In summary on the perimeter compactness measure, none of the three Senate plans included a district below the 0.05 level suggested for low compactness. Secondly, the means for all three plans were similar. But in spite of the fact that the Miller Plan had a marginally higher mean level of perimeter compactness, the Miller Plan included three districts of lesser compactness than the least compact district in the Enrolled Plan on the perimeter compactness measure.

The mean level of geographic dispersion compactness for Virginia's 40 state Senate districts as delineated in the Enrolled Plan was 0.35. This mean level of geographic dispersion compactness for the Enrolled Plan was virtually identical to the mean for the 1990s plan (0.35), but less in magnitude than that calculated for the Miller Plan (0.39).

As noted above, 0.15 has been suggested as a cut off point for low compactness on the geographic dispersion measure. Notably, two districts in the 1990s Plan and one each in the Enrolled and Miller Plans were below this level. Districts 18 (0.12) and 28 (0.14) in the 1990s Plan, District 40 (0.14) in the Enrolled Plan, and District 40 (0.14) in the Miller Plan, are below 0.15. In both the Miller and Enrolled Plans, District 40 includes the extreme western "toe" of the state creating an elongated district which scores poorly on the geographic dispersion measure.

In summary, the means for all three plans are very similar on the perimeter compactness measure. Secondly, no district in any of the three plans falls below the 0.05 benchmark for low compactness on the perimeter measure. But the 1990s Plan and the Miller Plan do have multiple districts of lower perimeter compactness than the least compact district in the Enrolled Plan. On the geographic dispersion compactness measure the means are similar between the 1990s Plan and Enrolled Plan, but higher on the Miller Plan.

Notably all three plans had districts below the 0.15 benchmark for low compactness. While only one each was included in the Miller and Enrolled Plans, the 1990s Plan included two. These results suggest that the Enrolled Plan is an improvement over the 1990s Plan in terms of the compactness criterion.

District Compactness for Virginia's State Senate Districts in Comparison to the Upper Chambers of Other Southern State Legislatures

Table 8 presents the average mean compactness for all state Senate districts in Alabama, South Carolina, Georgia, North Carolina, Virginia in the 1990s, and Virginia's 2001 Enrolled Plan. The mean level of perimeter compactness of Virginia's Enrolled Plan compares favorably to the averages in the other states. While the mean level of perimeter compactness of the Enrolled Plan (0.24) is less than that calculated for Georgia (0.29) or North Carolina (0.25), it is above the means for both Alabama (0.19) and South Carolina (0.18). In contrast, Virginia's 1991 and 2001 mean levels of Senate district dispersion compactness are less than those determined for the other states. This relative disparity may reflect the state of Virginia's more irregular shape when compared to the other states included.

(6) CONTIGUITY

Several states including Virginia require that legislative districts be composed of contiguous area (Grofman 1985: 84, 177-183). A district is typically defined as contiguous if every part of the district is accessible to all other parts without having to travel into a second district. This criterion rarely generates controversy. When controversy has arisen, the focus of contention has generally pertained to areas dissected by water features.

In the "Criteria" section of its February 23, 1991 guidelines for redistricting, Virginia's House Committee on Privileges and Elections stated the following:

Districts shall be composed of contiguous territory. Contiguity by water is acceptable to link territory within a district in order to meet the other criteria stated herein and provided that there is reasonable opportunity for travel within the district.

In its April 3, 2001 section on "Contiguity and Compactness," the House Committee on Privileges and Elections" states that "Districts shall be comprised of contiguous territory including adjoining insular territory. Contiguity by water is sufficient"

The use of water contiguity in Virginia is further supported in a 1984 opinion by the state's Attorney General (1984-85 Va. Op. AG. 128). As stated in the opinion, "it is held that territories not separated by intervening lands but only by water may be considered contiguous to each other." The opinion cites *First Virginia Bank v. Commonwealth*, 212 Va. 654, 655, 187 S.E.2d 186 (1972) in this conclusion.

On this basis, the contiguity of all three plans for the House of Delegates and Senate were examined using "Maptitude for Redistricting" software. Maptitude's "contiguity report" determines if any district is composed of more than a single polygon. If a district is composed of two or more polygons, it is classified as non-contiguous. All six plans tested were defined as contiguous by the Maptitude contiguity report.

(7) CONCLUSIONS

The purpose of this report was to evaluate the compliance of Virginia's 100 House of Delegates and 40 state Senate districts as included in the Enrolled Plans on the compactness

and contiguity criteria. For comparative purposes, this report also included analysis of Virginia's 1990s Plan and the Robinson Plan when discussing the House of Delegates, and the state's 1990s Plan and Miller Plan when discussing the Senate.

With respect to the House of Delegates, this analysis found that no district in the Enrolled Plan has a level of perimeter or geographic dispersion compactness below suggested cut off points for low compactness. Of the three plans, only the 1990s Plan included any districts that might be judged of "low" compactness on the geographic dispersion measure, and none of the three plans included a district below the suggested level on the perimeter measure.

A examination of the House of Delegates Enrolled Plan's mean level of compactness with state House plans for the 1990s in other Southern states determined the Enrolled plan compared favorably. While such comparisons must be undertaken cautiously given the contrasting geographic constraints found in different states, Virginia's Enrolled Plan was second only to Georgia on the perimeter compactness measure. On the geographic dispersion measure, Virginia's Enrolled Plan was equal to or above the means for most of the comparison states.

The evaluation of Virginia's state Senate districts produced generally similar results. The Enrolled Plan's levels of perimeter and geographic compactness were equal to or above the levels in the 1990s Plan. The Enrolled Plan also had fewer districts of comparatively low compactness than the 1990s Plan. The lowest district in terms of perimeter compactness in the Enrolled Plan was district 18 at 0.12. This level was higher than the lowest four districts in the 1990s Plan. Finally, the Senate Enrolled Plan compared favorably with the mean levels of perimeter compactness for the state senates in five other states. While

comparing less favorably to the other five states on the geographic dispersion measure, the disparity is moderate as opposed to substantial. Arguably the contrast may in part be due to Virginia's comparatively irregular shape and the constraints it places on efforts to create highly compact districts.

All six plans examined were also tested for geographic contiguity. For the House of Delegates, the current plan, the Enrolled Plan, and the Robinson Plan were all found to be composed of contiguous districts. For the Senate, the current plan, the Enrolled Plan, and the Miller Plan were all found to be composed of contiguous districts.

In conclusion, I find both the House of Delegates and state Senate districts as defined in the respective Enrolled Plans to meet the expectations of the compactness and contiguity criteria. The levels of geographic compactness in both chambers' 2001 plans meet or exceed the levels existing in the 1990s Plans. Both plans were further determined to have no non-contiguous districts.

September 1, 2001

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Qualifications, Publications and Compensation.

My vita accompanies this report, and list my qualifications and all publications. My hourly fee is \$125.

Testimony in Court or by Deposition in past five years:

Dillard v. City of Greensboro, Alabama (M.D. AL), 1996.

Cannon v. Durham County Board of Elections (E.D. NC), 1996.

Dillard v. Baldwin County Commission (M.D. AL), 1997.

Stovall et al., v. City of Cocoa, Florida (M.D. FL), 1997.

Rice v. Bennett (Montgomery County, AL, Circuit Court), 1997.

Cromartie v. Hunt (E.D. NC), 1997.

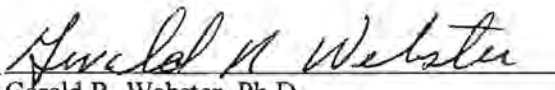
Daly v. Leak (E.D. NC) 1998.

Maxwell et al., v. Foster (W.D. LA), 1999.

Thompson v. Smith (M.D. AL), 1999.

Del Rio v. Perry (Travis County, TX) and Associated Republicans of Texas v. Cuellar (Harris County, TX), 2001.

Signed:



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Date:

Sept. 1, 2001

Table 1
Compactness of 1990s, Enrolled and Robinson House of Delegates Plans
By District Number

District	Perimeter Compactness			Geographic Dispersion Compactness		
	1990's Plan	Robinson Plan	Enrolled Plan	1990's Plan	Robinson Plan	Enrolled Plan
District 1	0.31	0.23	0.23	0.25	0.25	0.18
District 2	0.39	0.29	0.23	0.55	0.51	0.36
District 3	0.36	0.22	0.19	0.51	0.36	0.38
District 4	0.60	0.60	0.29	0.45	0.45	0.40
District 5	0.30	0.29	0.23	0.41	0.46	0.43
District 6	0.31	0.24	0.21	0.57	0.44	0.38
District 7	0.25	0.16	0.16	0.45	0.30	0.32
District 8	0.18	0.21	0.44	0.29	0.32	0.52
District 9	0.14	0.16	0.20	0.25	0.45	0.32
District 10	0.18	0.21	0.20	0.19	0.37	0.33
District 11	0.17	0.29	0.26	0.29	0.48	0.48
District 12	0.29	0.40	0.22	0.58	0.59	0.23
District 13	0.22	0.26	0.16	0.32	0.41	0.36
District 14	0.17	0.24	0.18	0.40	0.35	0.18
District 15	0.25	0.34	0.23	0.36	0.47	0.44
District 16	0.23	0.34	0.12	0.46	0.55	0.33
District 17	0.11	0.23	0.13	0.34	0.44	0.33
District 18	0.31	0.35	0.28	0.41	0.50	0.47
District 19	0.15	0.24	0.24	0.44	0.46	0.55
District 20	0.24	0.34	0.18	0.43	0.33	0.47
District 21	0.18	0.29	0.17	0.24	0.45	0.21
District 22	0.20	0.16	0.20	0.26	0.31	0.39
District 23	0.22	0.17	0.21	0.38	0.30	0.36
District 24	0.16	0.21	0.20	0.35	0.44	0.57
District 25	0.27	0.22	0.24	0.31	0.39	0.44
District 26	0.18	0.15	0.54	0.23	0.36	0.52
District 27	0.37	0.39	0.23	0.41	0.37	0.30
District 28	0.50	0.26	0.29	0.55	0.52	0.49
District 29	0.34	0.28	0.31	0.46	0.46	0.45
District 30	0.43	0.23	0.35	0.60	0.42	0.59
District 31	0.29	0.45	0.15	0.48	0.60	0.34
District 32	0.21	0.30	0.36	0.23	0.34	0.35
District 33	0.26	0.29	0.33	0.50	0.43	0.42
District 34	0.25	0.30	0.27	0.25	0.33	0.30
District 35	0.19	0.34	0.31	0.41	0.37	0.38
District 36	0.36	0.42	0.41	0.46	0.44	0.47
District 37	0.17	0.27	0.35	0.31	0.26	0.50
District 38	0.29	0.34	0.34	0.36	0.47	0.53
District 39	0.47	0.39	0.27	0.44	0.41	0.29
District 40	0.31	0.25	0.30	0.43	0.28	0.39
District 41	0.37	0.31	0.25	0.37	0.39	0.44
District 42	0.25	0.21	0.26	0.38	0.33	0.39
District 43	0.35	0.33	0.59	0.29	0.43	0.49
District 44	0.41	0.27	0.27	0.60	0.46	0.37
District 45	0.29	0.45	0.17	0.31	0.43	0.33
District 46	0.48	0.60	0.42	0.49	0.65	0.51
District 47	0.24	0.33	0.32	0.22	0.41	0.34
District 48	0.22	0.18	0.22	0.26	0.24	0.26
District 49	0.29	0.36	0.18	0.36	0.48	0.25
District 50	0.17	0.20	0.28	0.24	0.30	0.48
District 51	0.32	0.25	0.28	0.36	0.30	0.40
District 52	0.33	0.24	0.34	0.34	0.34	0.47
District 53	0.24	0.21	0.25	0.30	0.37	0.43
District 54	0.30	0.27	0.30	0.39	0.61	0.37
District 55	0.24	0.30	0.27	0.35	0.38	0.39
District 56	0.36	0.34	0.33	0.46	0.46	0.41
District 57	0.32	0.23	0.16	0.48	0.36	0.31
District 58	0.25	0.17	0.15	0.42	0.43	0.33

Source: Calculated by the University of Alabama Cartographic Laboratory

Table 1
Compactness of 1990s, Enrolled and Robinson House of Delegates Plans
By District Number

District	Perimeter Compactness			Geographic Dispersion Compactness		
	1990's Plan	Robinson Plan	Enrolled Plan	1990's Plan	Robinson Plan	Enrolled Plan
District 59	0.31	0.34	0.27	0.52	0.48	0.58
District 60	0.36	0.36	0.30	0.61	0.40	0.34
District 61	0.21	0.14	0.15	0.42	0.31	0.36
District 62	0.07	0.17	0.15	0.31	0.27	0.34
District 63	0.23	0.45	0.49	0.46	0.62	0.61
District 64	0.10	0.35	0.19	0.26	0.48	0.42
District 65	0.26	0.20	0.34	0.32	0.47	0.48
District 66	0.17	0.24	0.24	0.22	0.31	0.31
District 67	0.34	0.48	0.26	0.45	0.48	0.43
District 68	0.26	0.19	0.19	0.38	0.30	0.35
District 69	0.16	0.22	0.20	0.27	0.36	0.37
District 70	0.15	0.16	0.14	0.39	0.26	0.47
District 71	0.20	0.45	0.19	0.36	0.42	0.24
District 72	0.20	0.18	0.23	0.33	0.37	0.25
District 73	0.13	0.23	0.19	0.35	0.36	0.36
District 74	0.12	0.18	0.10	0.14	0.16	0.16
District 75	0.16	0.15	0.21	0.39	0.22	0.42
District 76	0.14	0.23	0.17	0.43	0.35	0.36
District 77	0.08	0.13	0.24	0.16	0.17	0.25
District 78	0.37	0.63	0.46	0.46	0.53	0.54
District 79	0.35	0.32	0.24	0.48	0.39	0.37
District 80	0.37	0.20	0.26	0.48	0.25	0.39
District 81	0.50	0.51	0.28	0.49	0.50	0.40
District 82	0.46	0.46	0.57	0.57	0.57	0.56
District 83	0.20	0.20	0.38	0.25	0.26	0.31
District 84	0.35	0.25	0.30	0.37	0.34	0.35
District 85	0.27	0.25	0.40	0.54	0.49	0.52
District 86	0.36	0.22	0.30	0.23	0.24	0.34
District 87	0.28	0.39	0.22	0.31	0.50	0.37
District 88	0.18	0.34	0.16	0.41	0.48	0.38
District 89	0.08	0.21	0.31	0.19	0.33	0.58
District 90	0.13	0.14	0.22	0.25	0.22	0.35
District 91	0.25	0.27	0.40	0.42	0.30	0.57
District 92	0.21	0.22	0.14	0.38	0.46	0.25
District 93	0.15	0.29	0.18	0.19	0.20	0.17
District 94	0.33	0.59	0.39	0.32	0.46	0.35
District 95	0.30	0.29	0.29	0.30	0.29	0.43
District 96	0.13	0.16	0.15	0.19	0.16	0.23
District 97	0.15	0.17	0.12	0.23	0.27	0.27
District 98	0.09	0.18	0.26	0.15	0.31	0.25
District 99	0.31	0.28	0.21	0.24	0.21	0.27
District 100	0.38	0.33	0.35	0.39	0.38	0.27
Mean	0.26	0.28	0.26	0.37	0.39	0.38
Standard Devialton	0.10	0.11	0.10	0.11	0.11	0.10

Source: Calculated by the University of Alabama Cartographic Laboratory

Table 2
Perimeter Compactness of 1990s, Enrolled and Robinson House of Delegates Plans
(in ascending order)

1990s Plan		Enrolled Plan		Robinson Plan	
District	Coefficient	District	Coefficient	District	Coefficient
District 62	0.07	District 74	0.10	District 77	0.13
District 77	0.08	District 16	0.12	District 61	0.14
District 89	0.08	District 97	0.12	District 90	0.14
District 98	0.09	District 17	0.13	District 26	0.15
District 64	0.10	District 70	0.14	District 75	0.15
District 17	0.11	District 92	0.14	District 7	0.16
District 74	0.12	District 31	0.15	District 9	0.16
District 73	0.13	District 58	0.15	District 22	0.16
District 90	0.13	District 61	0.15	District 70	0.16
District 96	0.13	District 62	0.15	District 96	0.16
District 9	0.14	District 96	0.15	District 23	0.17
District 76	0.14	District 7	0.16	District 58	0.17
District 19	0.15	District 13	0.16	District 62	0.17
District 70	0.15	District 57	0.16	District 97	0.17
District 93	0.15	District 88	0.16	District 48	0.18
District 97	0.15	District 21	0.17	District 72	0.18
District 24	0.16	District 45	0.17	District 74	0.18
District 69	0.16	District 76	0.17	District 98	0.18
District 75	0.16	District 14	0.18	District 68	0.19
District 11	0.17	District 20	0.18	District 50	0.20
District 14	0.17	District 49	0.18	District 65	0.20
District 37	0.17	District 93	0.18	District 80	0.20
District 50	0.17	District 3	0.19	District 83	0.20
District 66	0.17	District 64	0.19	District 8	0.21
District 8	0.18	District 68	0.19	District 10	0.21
District 10	0.18	District 71	0.19	District 24	0.21
District 21	0.18	District 73	0.19	District 42	0.21
District 26	0.18	District 9	0.20	District 53	0.21
District 88	0.18	District 10	0.20	District 89	0.21
District 35	0.19	District 22	0.20	District 3	0.22
District 22	0.20	District 24	0.20	District 25	0.22
District 71	0.20	District 69	0.20	District 69	0.22
District 72	0.20	District 6	0.21	District 86	0.22
District 83	0.20	District 23	0.21	District 92	0.22
District 32	0.21	District 75	0.21	District 1	0.23
District 61	0.21	District 99	0.21	District 17	0.23
District 92	0.21	District 12	0.22	District 30	0.23
District 13	0.22	District 48	0.22	District 57	0.23
District 23	0.22	District 87	0.22	District 73	0.23
District 48	0.22	District 90	0.22	District 76	0.23
District 16	0.23	District 1	0.23	District 6	0.24
District 63	0.23	District 2	0.23	District 14	0.24
District 20	0.24	District 5	0.23	District 19	0.24
District 47	0.24	District 15	0.23	District 52	0.24
District 53	0.24	District 27	0.23	District 66	0.24
District 55	0.24	District 72	0.23	District 40	0.25
District 7	0.25	District 19	0.24	District 51	0.25
District 15	0.25	District 25	0.24	District 84	0.25
District 34	0.25	District 66	0.24	District 85	0.25
District 42	0.25	District 77	0.24	District 13	0.26
District 58	0.25	District 79	0.24	District 28	0.26
District 91	0.25	District 41	0.25	District 37	0.27
District 33	0.26	District 53	0.25	District 44	0.27
District 65	0.26	District 11	0.26	District 54	0.27
District 68	0.26	District 42	0.26	District 91	0.27
District 25	0.27	District 67	0.26	District 29	0.28
District 85	0.27	District 80	0.26	District 99	0.28
District 87	0.28	District 98	0.26	District 2	0.29

Source: Calculated by the University of Alabama Cartographic Laboratory

Table 2
Perimeter Compactness of 1990s, Enrolled and Robinson House of Delegates Plans
(in ascending order)

1990s Plan		Enrolled Plan		Robinson Plan	
District	Coefficient	District	Coefficient	District	Coefficient
District 12	0.29	District 34	0.27	District 5	0.29
District 31	0.29	District 39	0.27	District 11	0.29
District 38	0.29	District 44	0.27	District 21	0.29
District 45	0.29	District 55	0.27	District 33	0.29
District 49	0.29	District 59	0.27	District 93	0.29
District 5	0.30	District 18	0.28	District 95	0.29
District 54	0.30	District 50	0.28	District 32	0.30
District 95	0.30	District 51	0.28	District 34	0.30
District 1	0.31	District 81	0.28	District 55	0.30
District 6	0.31	District 4	0.29	District 41	0.31
District 18	0.31	District 28	0.29	District 79	0.32
District 40	0.31	District 95	0.29	District 43	0.33
District 59	0.31	District 40	0.30	District 47	0.33
District 99	0.31	District 54	0.30	District 100	0.33
District 51	0.32	District 60	0.30	District 15	0.34
District 57	0.32	District 84	0.30	District 16	0.34
District 52	0.33	District 86	0.30	District 20	0.34
District 94	0.33	District 29	0.31	District 35	0.34
District 29	0.34	District 35	0.31	District 38	0.34
District 67	0.34	District 89	0.31	District 56	0.34
District 43	0.35	District 47	0.32	District 59	0.34
District 79	0.35	District 33	0.33	District 88	0.34
District 84	0.35	District 56	0.33	District 18	0.35
District 3	0.36	District 38	0.34	District 64	0.35
District 36	0.36	District 52	0.34	District 49	0.36
District 56	0.36	District 65	0.34	District 60	0.36
District 60	0.36	District 30	0.35	District 27	0.39
District 86	0.36	District 37	0.35	District 39	0.39
District 27	0.37	District 100	0.35	District 87	0.39
District 41	0.37	District 32	0.36	District 12	0.40
District 78	0.37	District 83	0.38	District 36	0.42
District 80	0.37	District 94	0.39	District 31	0.45
District 100	0.38	District 85	0.40	District 45	0.45
District 2	0.39	District 91	0.40	District 63	0.45
District 44	0.41	District 36	0.41	District 71	0.45
District 30	0.43	District 46	0.42	District 82	0.46
District 82	0.46	District 8	0.44	District 67	0.48
District 39	0.47	District 78	0.46	District 81	0.51
District 46	0.48	District 63	0.49	District 94	0.59
District 28	0.50	District 26	0.54	District 4	0.60
District 81	0.50	District 82	0.57	District 46	0.60
District 4	0.60	District 43	0.59	District 78	0.63
Mean	0.26		0.26		0.28
Standard Deviation	0.10		0.10		0.11

Source: Calculated by the University of Alabama Cartographic Laboratory

Table 3
Geographic Dispersion Compactness of 1990s, Enrolled and Robinson House of Delegates Plans
(in ascending order)

1990s Plan		Enrolled Plan		Robinson Plan	
District	Coefficient	District	Coefficient	District	Coefficient
District 74	0.14	District 74	0.16	District 74	0.16
District 98	0.15	District 93	0.17	District 96	0.16
District 77	0.16	District 1	0.18	District 77	0.17
District 10	0.19	District 14	0.18	District 93	0.20
District 89	0.19	District 21	0.21	District 99	0.21
District 93	0.19	District 12	0.23	District 75	0.22
District 96	0.19	District 96	0.23	District 90	0.22
District 47	0.22	District 71	0.24	District 48	0.24
District 66	0.22	District 49	0.25	District 86	0.24
District 26	0.23	District 72	0.25	District 1	0.25
District 32	0.23	District 77	0.25	District 80	0.25
District 86	0.23	District 92	0.25	District 37	0.26
District 97	0.23	District 98	0.25	District 70	0.26
District 21	0.24	District 48	0.26	District 83	0.26
District 50	0.24	District 97	0.27	District 62	0.27
District 99	0.24	District 99	0.27	District 97	0.27
District 1	0.25	District 100	0.27	District 40	0.28
District 9	0.25	District 39	0.29	District 95	0.29
District 34	0.25	District 27	0.30	District 7	0.30
District 83	0.25	District 34	0.30	District 23	0.30
District 90	0.25	District 57	0.31	District 50	0.30
District 22	0.26	District 66	0.31	District 51	0.30
District 48	0.26	District 83	0.31	District 68	0.30
District 64	0.26	District 7	0.32	District 91	0.30
District 69	0.27	District 9	0.32	District 22	0.31
District 8	0.29	District 10	0.33	District 61	0.31
District 11	0.29	District 16	0.33	District 66	0.31
District 43	0.29	District 17	0.33	District 98	0.31
District 53	0.30	District 45	0.33	District 8	0.32
District 95	0.30	District 58	0.33	District 20	0.33
District 25	0.31	District 31	0.34	District 34	0.33
District 37	0.31	District 47	0.34	District 42	0.33
District 45	0.31	District 60	0.34	District 89	0.33
District 62	0.31	District 62	0.34	District 32	0.34
District 87	0.31	District 86	0.34	District 52	0.34
District 13	0.32	District 32	0.35	District 84	0.34
District 65	0.32	District 68	0.35	District 14	0.35
District 94	0.32	District 84	0.35	District 76	0.35
District 72	0.33	District 90	0.35	District 3	0.36
District 17	0.34	District 94	0.35	District 26	0.36
District 52	0.34	District 2	0.36	District 57	0.36
District 24	0.35	District 13	0.36	District 69	0.36
District 55	0.35	District 23	0.36	District 73	0.36
District 73	0.35	District 61	0.36	District 10	0.37
District 15	0.36	District 73	0.36	District 27	0.37
District 38	0.36	District 76	0.36	District 35	0.37
District 49	0.36	District 88	0.36	District 53	0.37
District 51	0.36	District 44	0.37	District 72	0.37
District 71	0.36	District 54	0.37	District 55	0.38
District 41	0.37	District 69	0.37	District 100	0.38
District 84	0.37	District 79	0.37	District 25	0.39
District 23	0.38	District 87	0.37	District 41	0.39
District 42	0.38	District 3	0.38	District 79	0.39
District 68	0.38	District 6	0.38	District 60	0.40
District 92	0.38	District 35	0.38	District 13	0.41
District 64	0.39	District 22	0.39	District 39	0.41
District 70	0.39	District 40	0.39	District 47	0.41
District 75	0.39	District 42	0.39	District 30	0.42

Source: Calculated by the University of Alabama Cartographic Laboratory

Table 3
Geographic Dispersion Compactness of 1990s, Enrolled and Robinson House of Delegates Plans
(in ascending order)

1990s Plan		Enrolled Plan		Robinson Plan	
District	Coefficient	District	Coefficient	District	Coefficient
District 100	0.39	District 55	0.39	District 71	0.42
District 14	0.40	District 80	0.39	District 33	0.43
District 5	0.41	District 4	0.40	District 43	0.43
District 18	0.41	District 51	0.40	District 45	0.43
District 27	0.41	District 81	0.40	District 58	0.43
District 35	0.41	District 56	0.41	District 6	0.44
District 88	0.41	District 33	0.42	District 17	0.44
District 58	0.42	District 64	0.42	District 24	0.44
District 61	0.42	District 75	0.42	District 36	0.44
District 91	0.42	District 5	0.43	District 4	0.45
District 20	0.43	District 53	0.43	District 9	0.45
District 40	0.43	District 67	0.43	District 21	0.45
District 76	0.43	District 95	0.43	District 5	0.46
District 19	0.44	District 15	0.44	District 19	0.46
District 39	0.44	District 25	0.44	District 29	0.46
District 4	0.45	District 41	0.44	District 44	0.46
District 7	0.45	District 29	0.45	District 56	0.46
District 67	0.45	District 18	0.47	District 92	0.46
District 16	0.46	District 20	0.47	District 94	0.46
District 29	0.46	District 36	0.47	District 15	0.47
District 36	0.46	District 52	0.47	District 38	0.47
District 56	0.46	District 70	0.47	District 65	0.47
District 63	0.46	District 11	0.48	District 11	0.48
District 78	0.46	District 50	0.48	District 49	0.48
District 31	0.48	District 65	0.48	District 59	0.48
District 57	0.48	District 28	0.49	District 64	0.48
District 79	0.48	District 43	0.49	District 67	0.48
District 80	0.48	District 37	0.50	District 88	0.48
District 46	0.49	District 46	0.51	District 85	0.49
District 81	0.49	District 8	0.52	District 18	0.50
District 33	0.50	District 26	0.52	District 81	0.50
District 3	0.51	District 85	0.52	District 87	0.50
District 59	0.52	District 38	0.53	District 2	0.51
District 85	0.54	District 78	0.54	District 28	0.52
District 2	0.55	District 19	0.55	District 78	0.53
District 28	0.55	District 82	0.56	District 16	0.55
District 6	0.57	District 24	0.57	District 82	0.57
District 82	0.57	District 91	0.57	District 12	0.59
District 12	0.58	District 59	0.58	District 31	0.60
District 30	0.60	District 89	0.58	District 54	0.61
District 44	0.60	District 30	0.59	District 63	0.62
District 60	0.61	District 63	0.61	District 46	0.65
Mean	0.37		0.38		0.39
Standard Devialton	0.11		0.10		0.11

Source: Calculated by the University of Alabama Cartographic Laboratory

Table 4
Mean Lower Legislative Chamber District Compactness^a

State	Mean Dispersion Compactness	Mean Perimeter Compactness
Alabama (1993)	.38	.25
South Carolina (1996)	.36	.24
Georgia (1996)	.39	.29
Louisiana (1991)	.37	.26
North Carolina (1991)	.38	.25
Virginia (1991)	.37	.26
Virginia (2001)	.38	.26

^a All data are drawn from the records of the author's past work on disticting cases. Data for districts in South Carolina, Georgia and North Carolina were originally secured from Election Data Services. Data for districts in Alabama and Louisiana were calculated by the University of Alabama Cartography Lab. By 1996 several districts in South Carolina and Georgia had been redrawn due to Shaw challenges.

Table 5
Compactness of 1990s, Enrolled and Miller State Senate Plans
By District Number

District	Perimeter Compactness			Geographic Dispersion Compactness		
	1990's Plan	Miller Plan	Enrolled Plan	1990's Plan	Miller Plan	Enrolled Plan
District 1	0.22	0.23	0.23	0.50	0.48	0.42
District 2	0.09	0.20	0.29	0.21	0.29	0.45
District 3	0.21	0.25	0.18	0.28	0.28	0.28
District 4	0.30	0.15	0.25	0.39	0.36	0.31
District 5	0.18	0.11	0.15	0.30	0.24	0.35
District 6	0.27	0.30	0.31	0.39	0.45	0.31
District 7	0.21	0.23	0.20	0.32	0.49	0.29
District 8	0.34	0.39	0.41	0.35	0.53	0.29
District 9	0.14	0.12	0.16	0.26	0.28	0.24
District 10	0.19	0.20	0.30	0.29	0.39	0.54
District 11	0.31	0.25	0.39	0.38	0.54	0.48
District 12	0.14	0.11	0.36	0.18	0.21	0.43
District 13	0.18	0.41	0.20	0.24	0.50	0.42
District 14	0.35	0.20	0.32	0.49	0.31	0.44
District 15	0.10	0.22	0.18	0.23	0.38	0.40
District 16	0.09	0.09	0.17	0.33	0.31	0.36
District 17	0.32	0.19	0.34	0.38	0.33	0.49
District 18	0.10	0.37	0.12	0.12	0.49	0.22
District 19	0.43	0.37	0.25	0.37	0.66	0.41
District 20	0.42	0.30	0.23	0.46	0.44	0.32
District 21	0.43	0.32	0.18	0.63	0.48	0.32
District 22	0.17	0.25	0.13	0.26	0.40	0.24
District 23	0.33	0.32	0.21	0.47	0.48	0.44
District 24	0.27	0.12	0.24	0.39	0.23	0.42
District 25	0.31	0.24	0.14	0.35	0.31	0.23
District 26	0.18	0.24	0.28	0.27	0.23	0.43
District 27	0.24	0.30	0.19	0.38	0.46	0.33
District 28	0.13	0.27	0.19	0.14	0.37	0.16
District 29	0.36	0.46	0.27	0.34	0.43	0.31
District 30	0.17	0.17	0.21	0.34	0.34	0.29
District 31	0.32	0.49	0.34	0.43	0.51	0.51
District 32	0.32	0.40	0.33	0.48	0.50	0.38
District 33	0.41	0.28	0.40	0.51	0.32	0.47
District 34	0.21	0.26	0.32	0.29	0.32	0.46
District 35	0.22	0.31	0.24	0.49	0.53	0.49
District 36	0.32	0.32	0.21	0.49	0.49	0.32
District 37	0.19	0.24	0.25	0.36	0.40	0.25
District 38	0.19	0.24	0.14	0.38	0.43	0.21
District 39	0.15	0.26	0.21	0.24	0.45	0.30
District 40	0.18	0.13	0.17	0.20	0.14	0.14
Mean	0.24	0.26	0.24	0.35	0.39	0.35
Standard Deviaton	0.10	0.11	0.08	0.11	0.11	0.10

Source: Calculated by the University of Alabama Cartographic Laboratory

Table 6
Perimeter Compactness of 1990s, Enrolled and Miller State Senate Plans
(in ascending order)

1990s Plan		Enrolled Plan		Miller Plan	
District	Coefficient	District	Coefficient	District	Coefficient
District 16	0.09	District 18	0.12	District 16	0.09
District 2	0.09	District 22	0.13	District 5	0.11
District 15	0.10	District 25	0.14	District 12	0.11
District 18	0.10	District 38	0.14	District 9	0.12
District 28	0.13	District 5	0.15	District 24	0.12
District 12	0.14	District 9	0.16	District 40	0.13
District 9	0.14	District 16	0.17	District 4	0.15
District 39	0.15	District 40	0.17	District 30	0.17
District 22	0.17	District 3	0.18	District 17	0.19
District 30	0.17	District 15	0.18	District 2	0.20
District 13	0.18	District 21	0.18	District 10	0.20
District 26	0.18	District 27	0.19	District 14	0.20
District 40	0.18	District 28	0.19	District 15	0.22
District 5	0.18	District 7	0.20	District 1	0.23
District 10	0.19	District 13	0.20	District 7	0.23
District 37	0.19	District 23	0.21	District 25	0.24
District 38	0.19	District 30	0.21	District 26	0.24
District 3	0.21	District 36	0.21	District 37	0.24
District 34	0.21	District 39	0.21	District 38	0.24
District 7	0.21	District 1	0.23	District 3	0.25
District 1	0.22	District 20	0.23	District 11	0.25
District 35	0.22	District 24	0.24	District 22	0.25
District 27	0.24	District 35	0.24	District 34	0.26
District 24	0.27	District 4	0.25	District 39	0.26
District 6	0.27	District 19	0.25	District 28	0.27
District 4	0.30	District 37	0.25	District 33	0.28
District 11	0.31	District 29	0.27	District 6	0.30
District 25	0.31	District 26	0.28	District 20	0.30
District 17	0.32	District 2	0.29	District 27	0.30
District 31	0.32	District 10	0.30	District 35	0.31
District 32	0.32	District 6	0.31	District 21	0.32
District 36	0.32	District 14	0.32	District 23	0.32
District 23	0.33	District 34	0.32	District 36	0.32
District 8	0.34	District 32	0.33	District 18	0.37
District 14	0.35	District 17	0.34	District 19	0.37
District 29	0.36	District 31	0.34	District 8	0.39
District 33	0.41	District 12	0.36	District 32	0.40
District 20	0.42	District 11	0.39	District 13	0.41
District 19	0.43	District 33	0.40	District 29	0.46
District 21	0.43	District 8	0.41	District 31	0.49
Mean	0.24		0.24		0.26
Standard Deviaton	0.10		0.08		0.11

Source: Calculated by the University of Alabama Cartographic Laboratory

Table 7
Geographic Dispersion Compactness of 1990s, Enrolled and Miller State Senate Plans
(in ascending order)

1990s Plan		Enrolled Plan		Miller Plan	
District	Coefficient	District	Coefficient	District	Coefficient
District 18	0.12	District 40	0.14	District 40	0.14
District 28	0.14	District 28	0.16	District 12	0.21
District 12	0.18	District 38	0.21	District 24	0.23
District 40	0.20	District 18	0.22	District 26	0.23
District 2	0.21	District 25	0.23	District 5	0.24
District 15	0.23	District 9	0.24	District 3	0.28
District 13	0.24	District 22	0.24	District 9	0.28
District 39	0.24	District 37	0.25	District 2	0.29
District 9	0.26	District 3	0.28	District 14	0.31
District 22	0.26	District 7	0.29	District 16	0.31
District 26	0.27	District 8	0.29	District 25	0.31
District 3	0.28	District 30	0.29	District 33	0.32
District 10	0.29	District 39	0.30	District 34	0.32
District 34	0.29	District 4	0.31	District 17	0.33
District 5	0.30	District 6	0.31	District 30	0.34
District 7	0.32	District 29	0.31	District 4	0.36
District 16	0.33	District 20	0.32	District 28	0.37
District 29	0.34	District 21	0.32	District 15	0.38
District 30	0.34	District 36	0.32	District 10	0.39
District 8	0.35	District 27	0.33	District 22	0.40
District 25	0.35	District 5	0.35	District 37	0.40
District 37	0.36	District 16	0.36	District 29	0.43
District 19	0.37	District 32	0.38	District 38	0.43
District 11	0.38	District 15	0.40	District 20	0.44
District 17	0.38	District 19	0.41	District 6	0.45
District 27	0.38	District 1	0.42	District 39	0.45
District 38	0.38	District 13	0.42	District 27	0.46
District 4	0.39	District 24	0.42	District 1	0.48
District 6	0.39	District 12	0.43	District 21	0.48
District 24	0.39	District 26	0.43	District 23	0.48
District 31	0.43	District 14	0.44	District 7	0.49
District 20	0.46	District 23	0.44	District 18	0.49
District 23	0.47	District 2	0.45	District 36	0.49
District 32	0.48	District 34	0.46	District 13	0.50
District 14	0.49	District 33	0.47	District 32	0.50
District 35	0.49	District 11	0.48	District 31	0.51
District 36	0.49	District 17	0.49	District 8	0.53
District 1	0.50	District 35	0.49	District 35	0.53
District 33	0.51	District 31	0.51	District 11	0.54
District 21	0.63	District 10	0.54	District 19	0.66
Mean	0.35		0.35		0.39
Standard Devialton	0.11		0.10		0.11

Source: Calculated by the University of Alabama Cartographic Laboratory

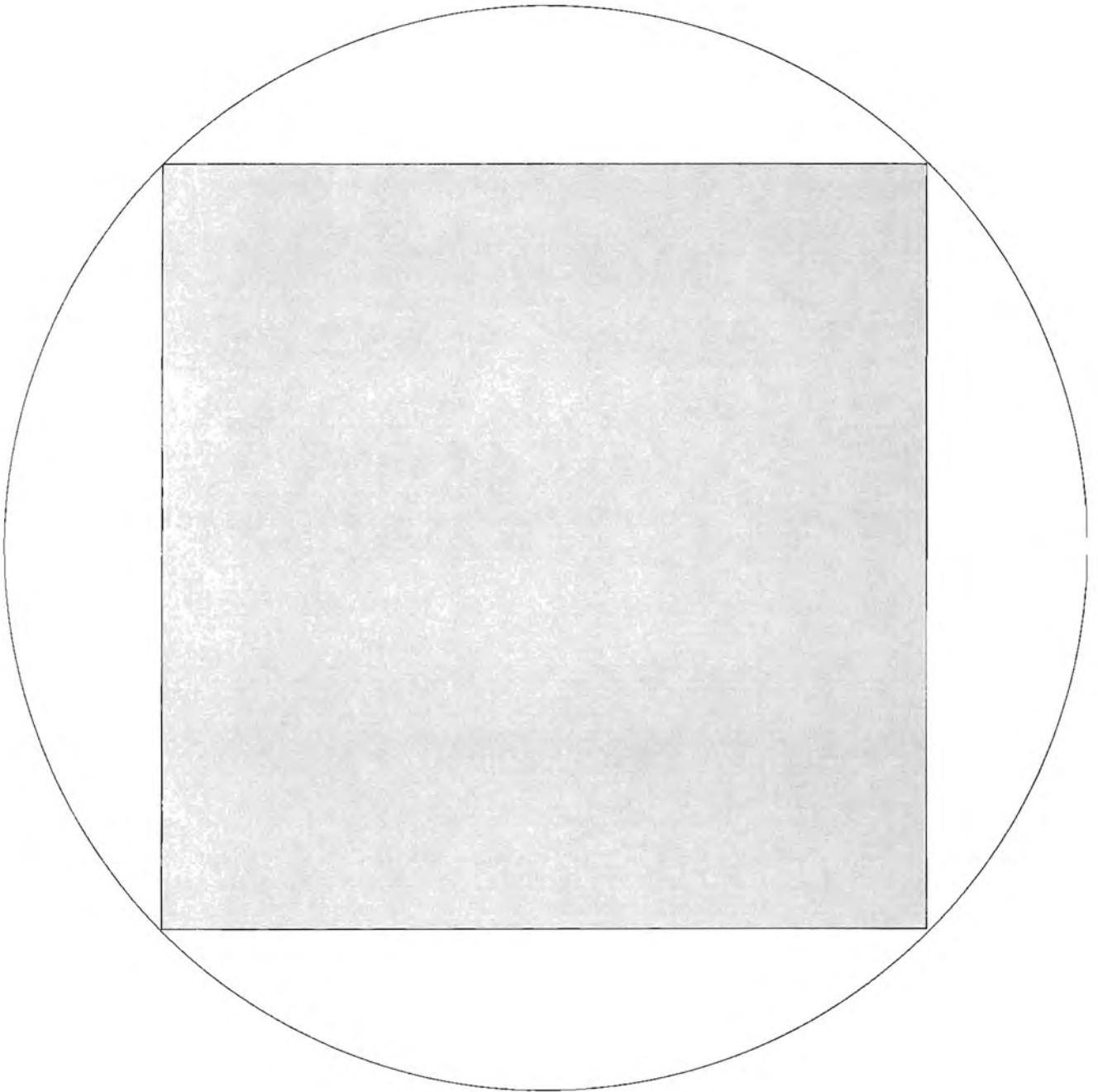
Table 8

Mean State Senate District Compactness^a

State	Mean Dispersion Compactness	Mean Perimeter Compactness
Alabama (1993)	.37	.19
South Carolina (1996)	.36	.18
Georgia (1996)	.41	.29
North Carolina (1991)	.38	.25
Virginia (1991)	.35	.24
Virginia (2001)	.35	.24

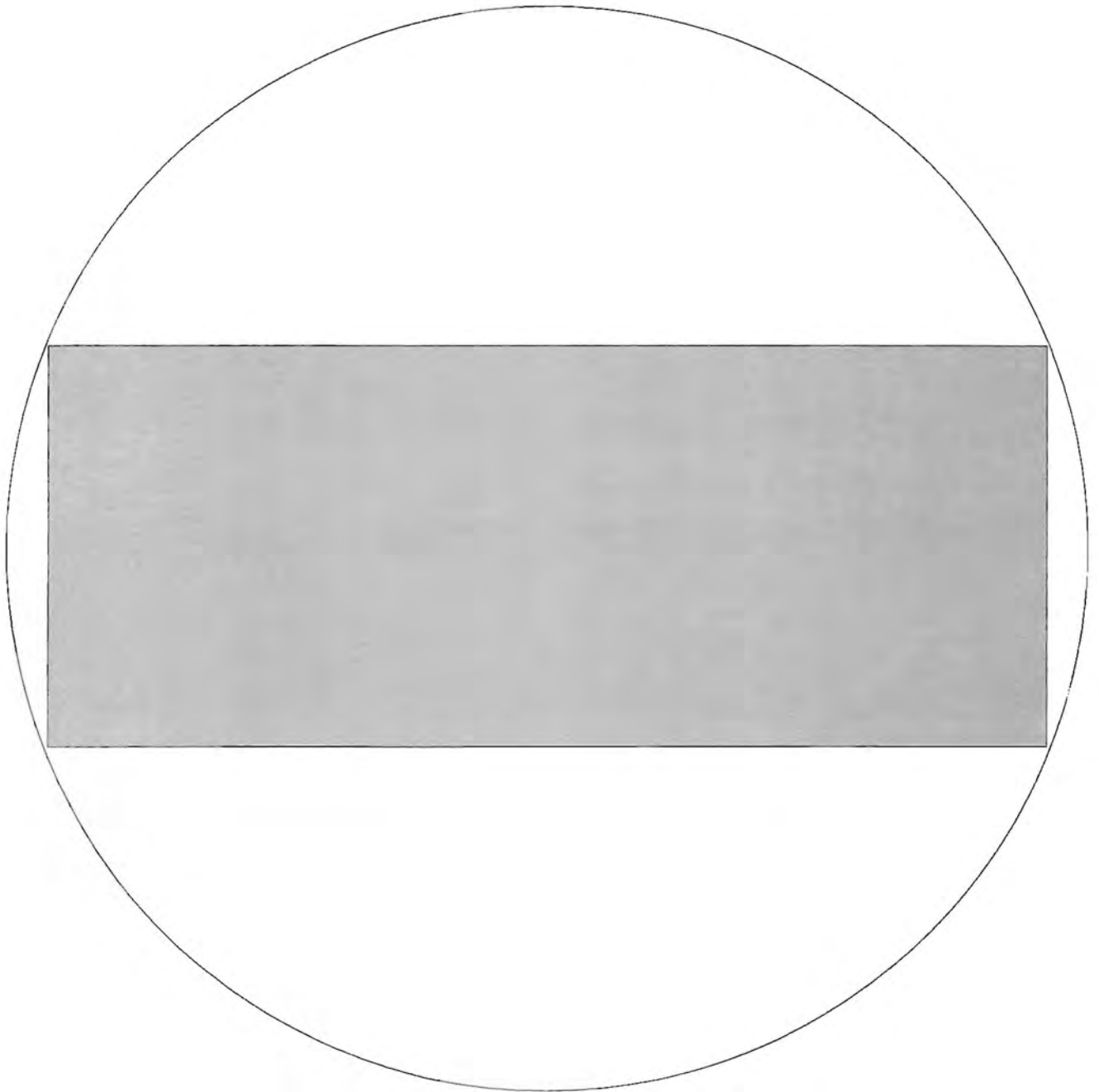
^a All data are drawn from the records of the author's past work on districting cases. Data for districts in South Carolina, Georgia and North Carolina were originally secured from Election Data Services. Data for Alabama and Virginia were calculated by the University of Alabama Cartography Laboratory. By 1996 several districts in South Carolina and Georgia had been redrawn due to successful Shaw challenges.

Figure 1 - Compactness of a Square



Dispersion Compactness = .640
Perimeter Compactness = .785

Figure 2 - Compactness of a Rectangle



Dispersion Compactness = .431
Perimeter Compactness = .641

Figure 3 - State of Virginia



Compactness Dispersion = 0.229
Compactness Perimeter = 0.163

Figure 4 - City of Newport News



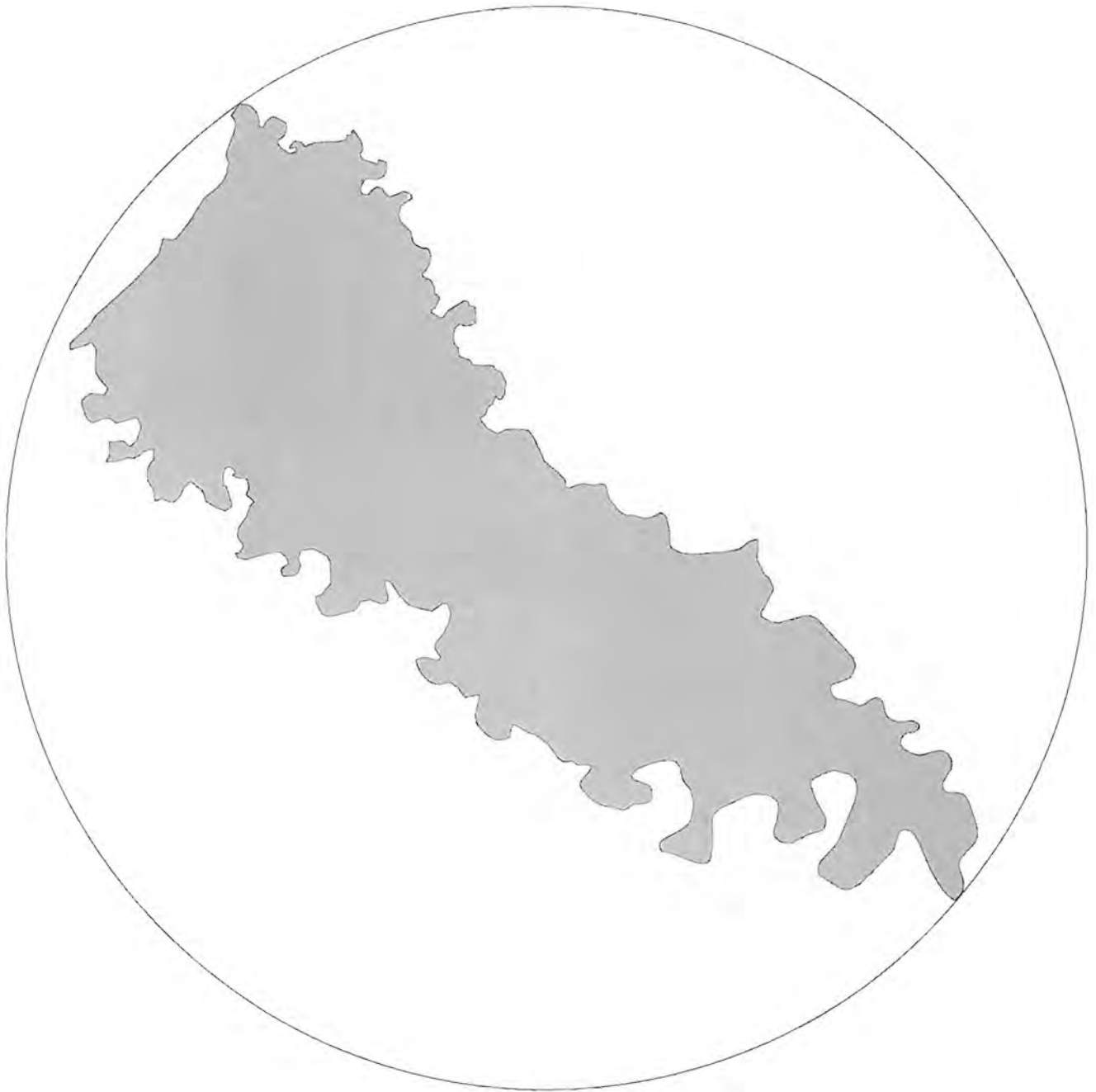
Compactness Dispersion = 0.219
Compactness Perimeter = 0.307

Figure 5 - Lee County



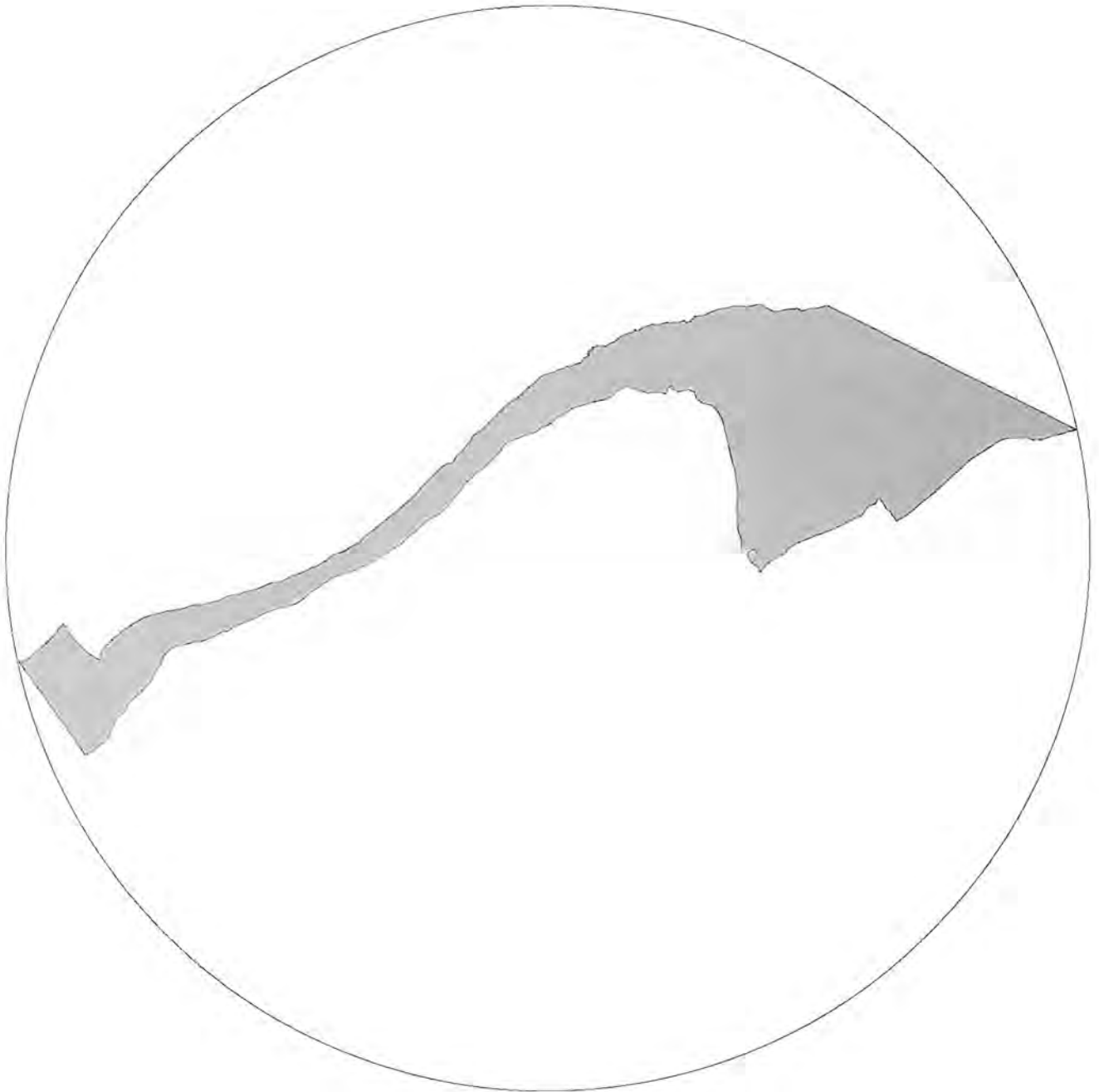
Compactness Dispersion = 0.204
Compactness Perimeter = 0.352

Figure 6 - King William County



Compactness Dispersion = 0.267
Compactness Perimeter = 0.159

Figure 7 - Bennett Springs Voting Precinct
(Roanoke County)



Compactness Dispersion = 0.093
Compactness Perimeter = 0.144

Figure 8 - Scottsburg Voting Precinct
(Halifax County)



Compactness Dispersion = 0.203
Compactness Perimeter = 0.255

Figure 9 - Sunray I Voting Precinct
(City of Chesapeake)



Compactness Dispersion = 0.160
Compactness Perimeter = 0.178

Figure 10 - Virginia State Assembly Enrolled Plan

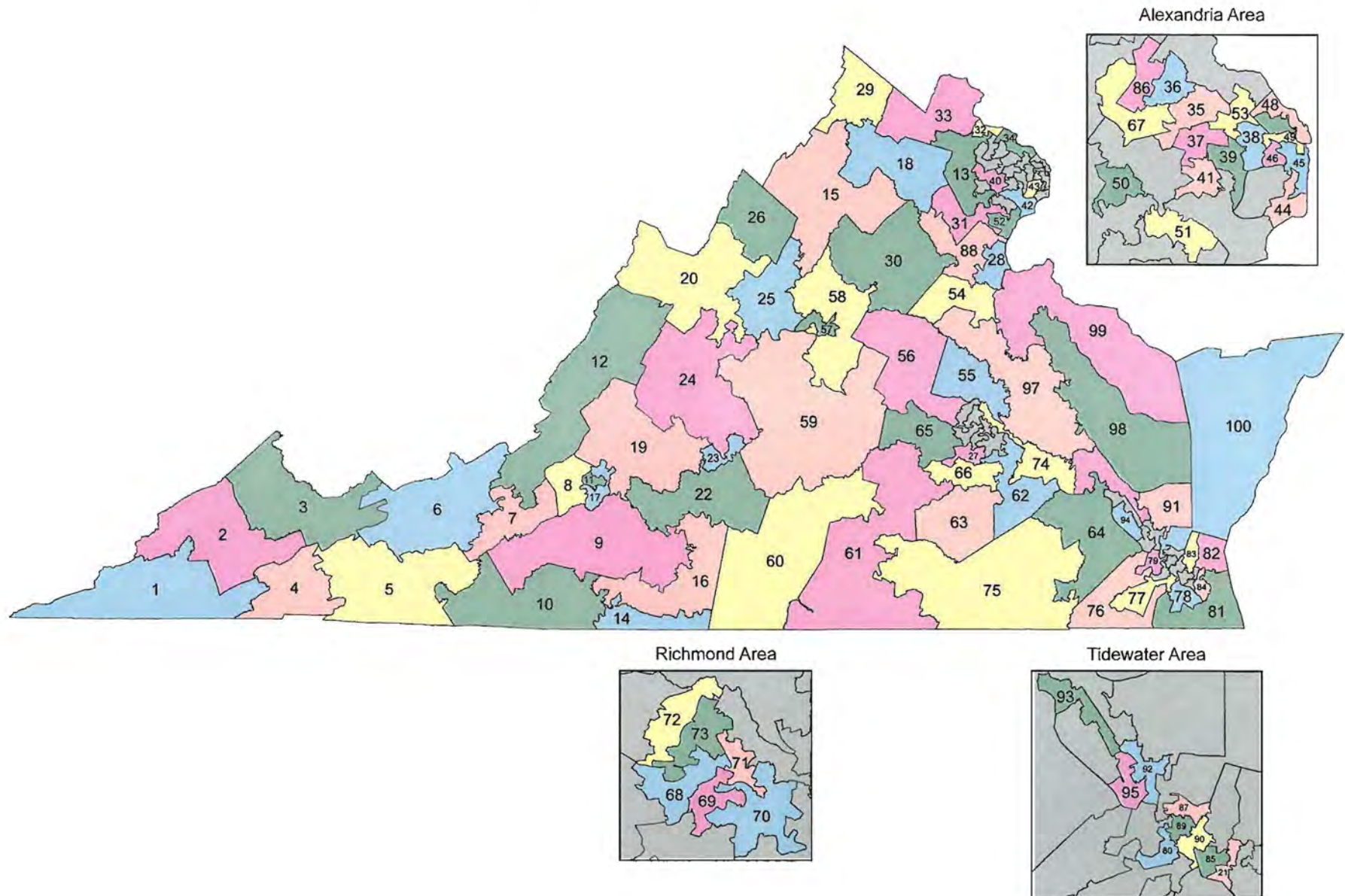


Figure 11 - Virginia State Assembly 1990's Plan

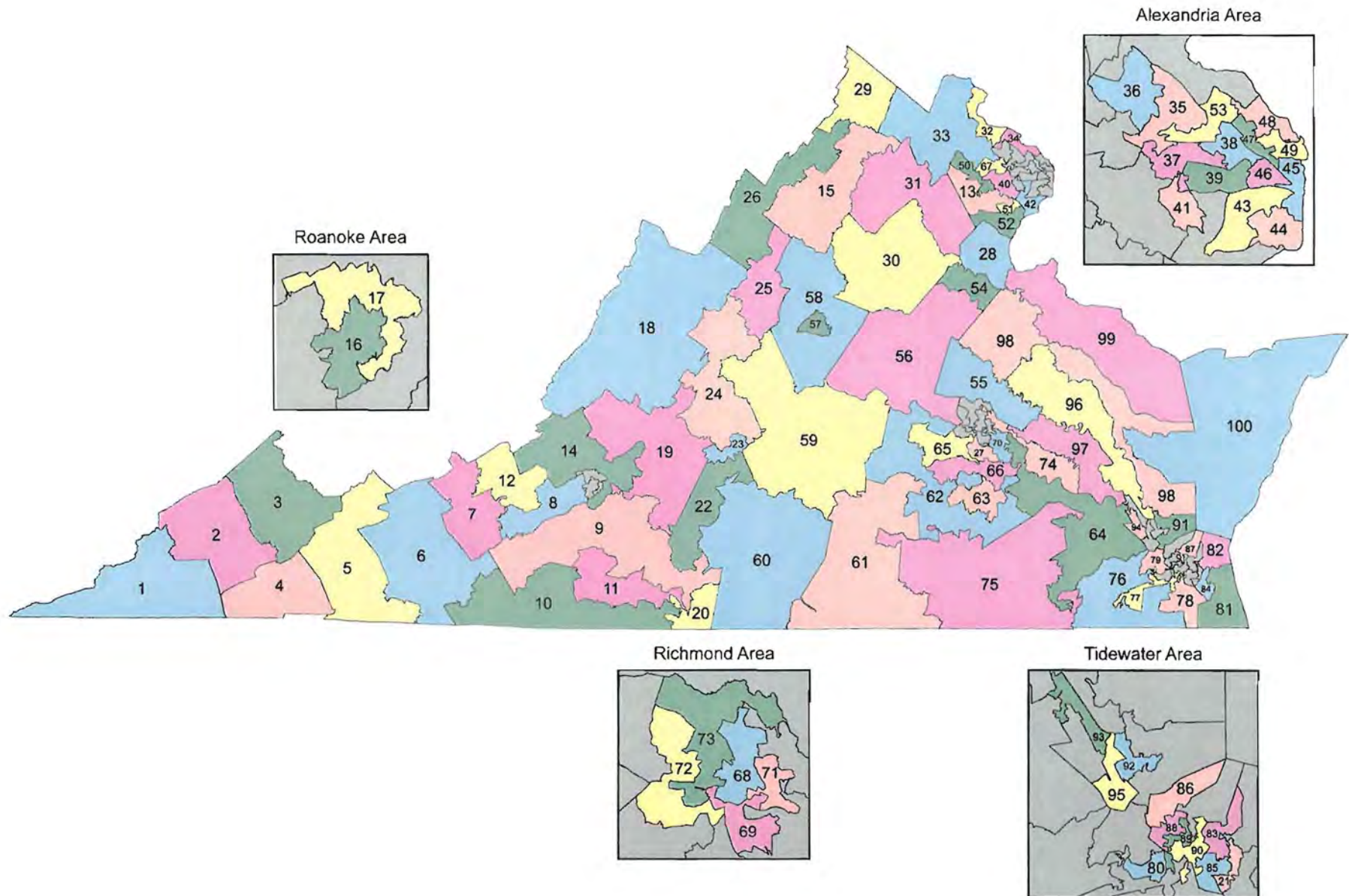


Figure 12 - Virginia State Assembly Robinson Plan

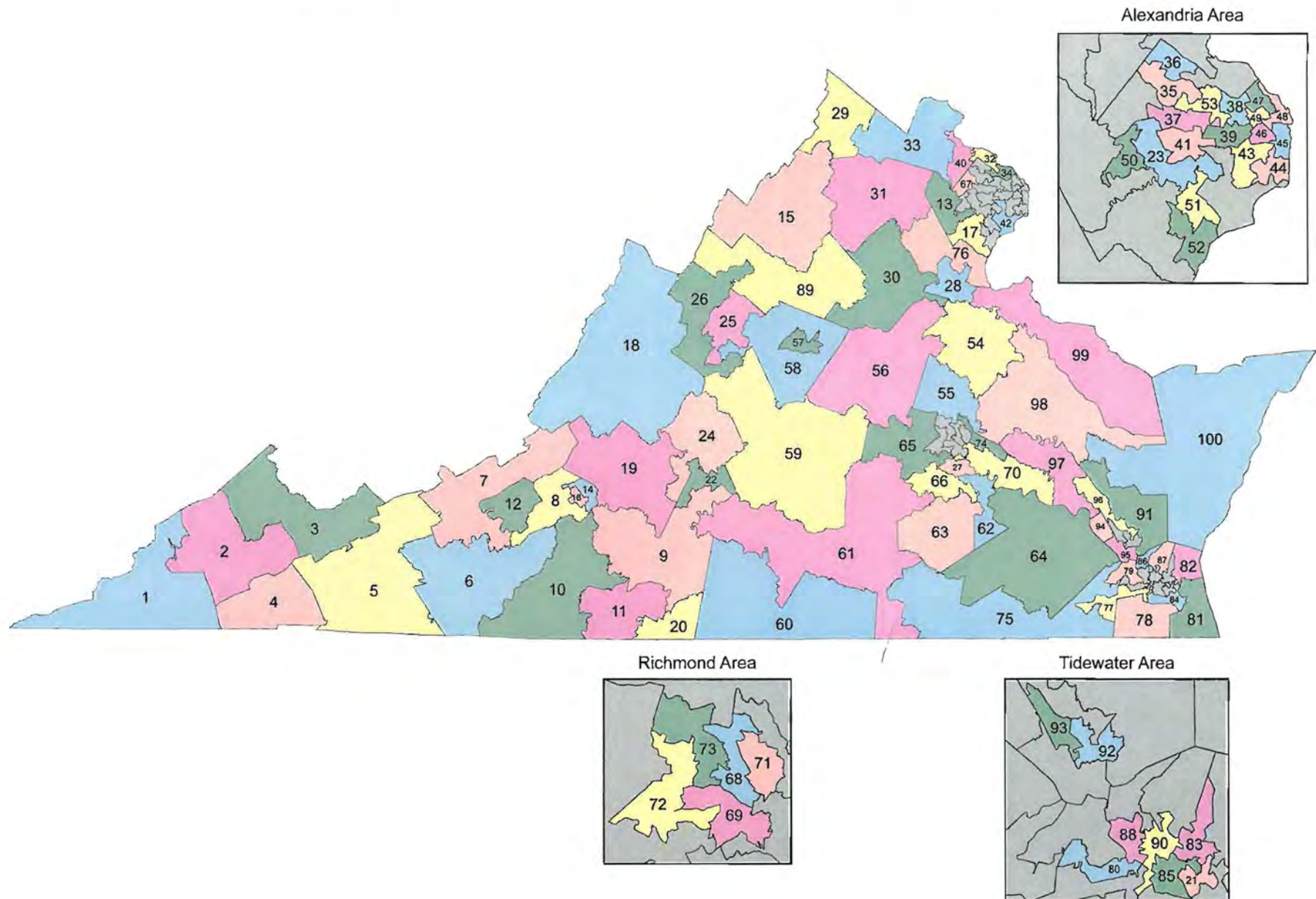


Figure 13 - Virginia State Senate Enrolled Plan

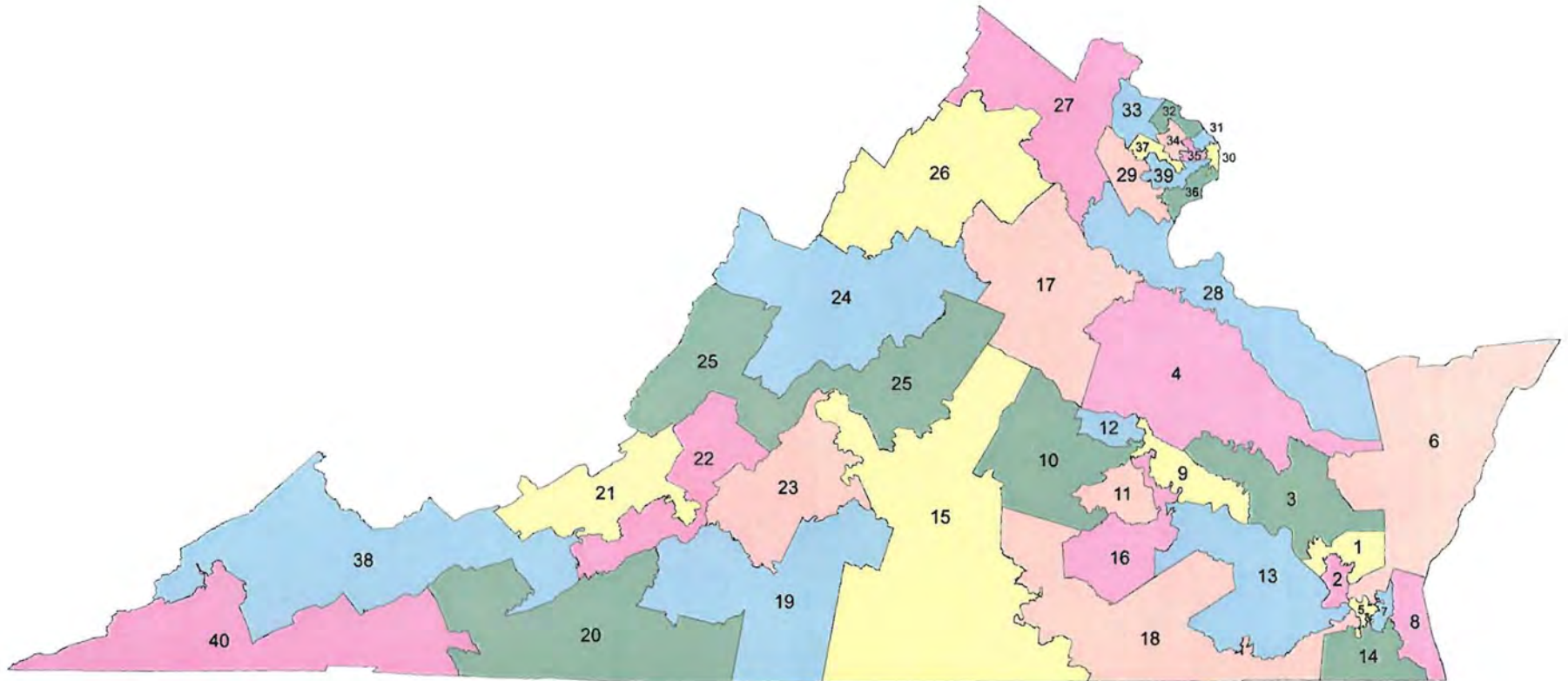


Figure 14 - Virginia State Senate 1990's Plan

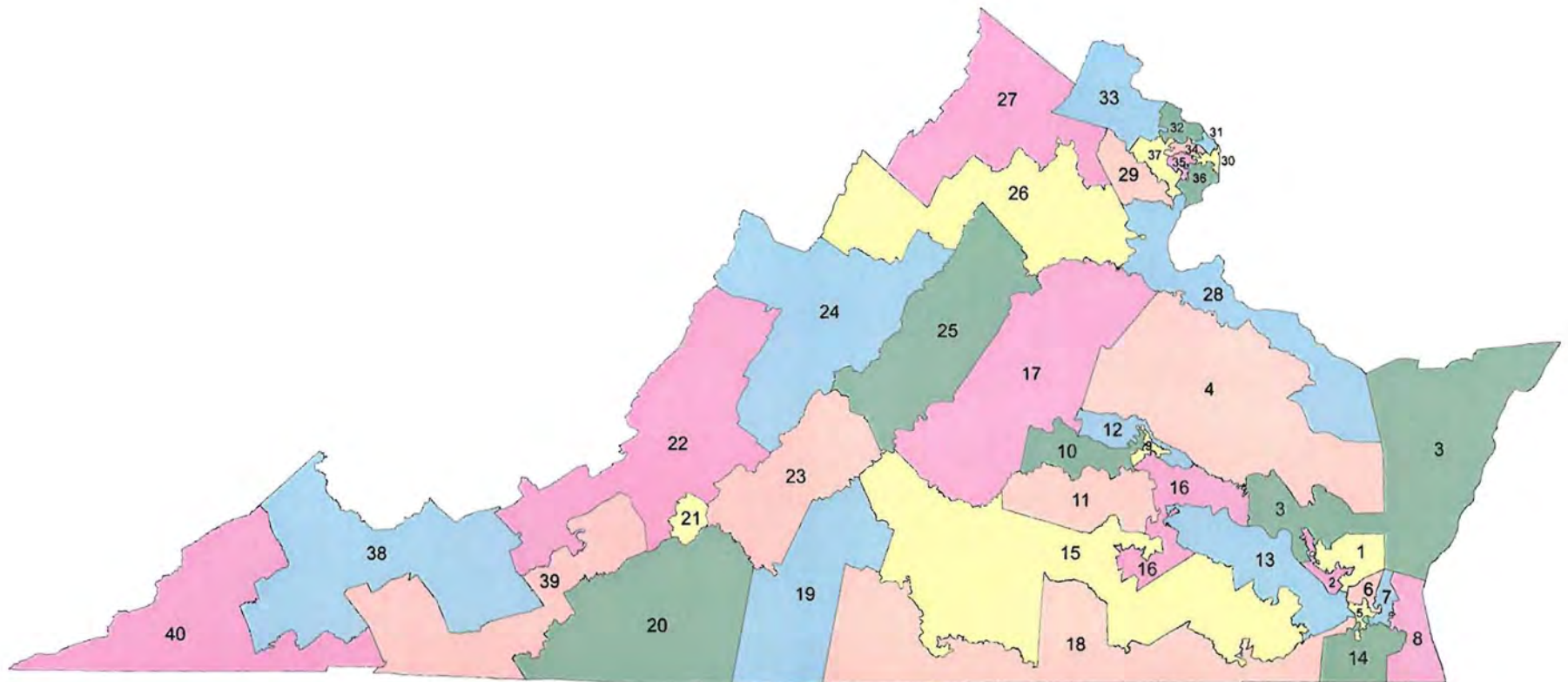
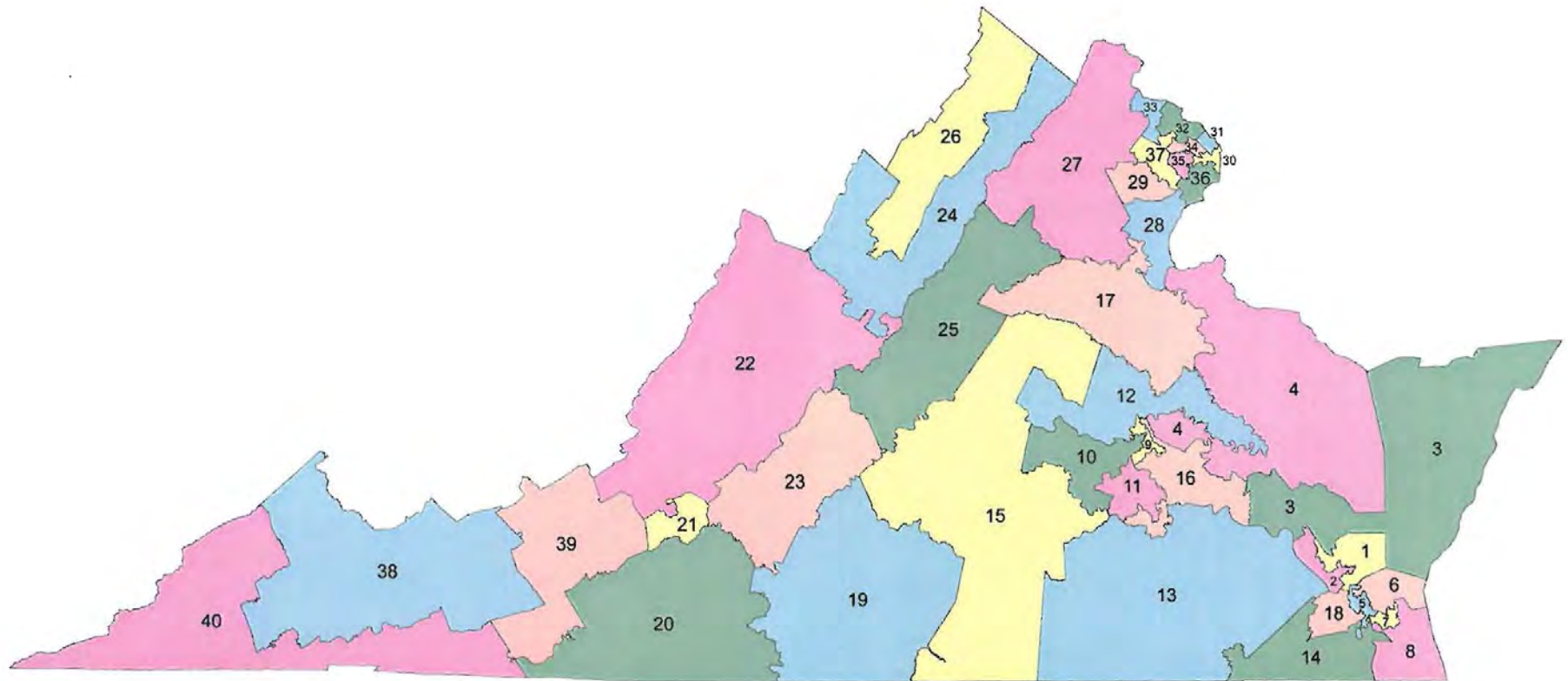


Figure 15 - Virginia State Senate Miller Plan



Richmond schools slated for closure following rezoning

POSTED 1:54 PM, MAY 21, 2012, BY JERRITA PATTERSON, UPDATED AT 01:56PM, MAY 21, 2012



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Richmond Rezoning



RICHMOND, Va. (WTVR) – Concerned parents are sounding off over news that their child's elementary school could close. Monday evening, a Richmond Public Schools rezoning committee is set to present its latest plan to the public.

The volunteer committee will go before the school board with their findings. They're expected to recommend which schools should stay open and which ones should close.

For months the volunteer committee has been working to balance attendance affecting many of Richmond's schools. As a result Fisher and John B. Cary Elementary Schools could possibly be closed by the Fall.

"I grew up in the neighborhood," said parent Damani Ryan. "I went here (John B. Cary), both my sisters went here."

Also facing the chopping block is Summer Hill Elementary.

"It hurts me to know that this will not still be here for the next generation,

"said parent Nicole Blackwell. "It's really troubling to me."

"It's just like an extended family," said grandmother Patricia Blackwell.

After the rezoning committee presents options to the School Board, two public hearings will take place on May 29 and 31. After which, the board is set to vote on a proposal June 18.

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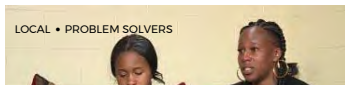
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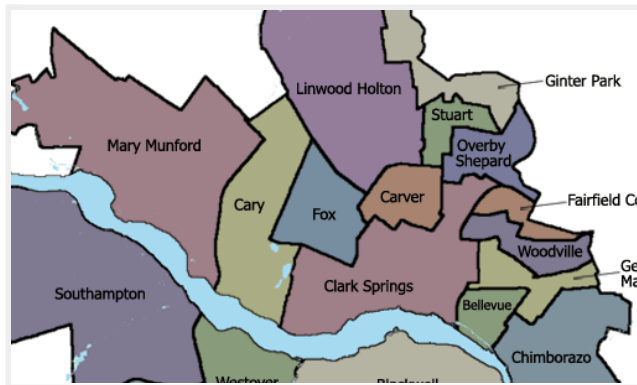
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A primer on rezoning and school closing

The School Board of Richmond Public Schools will consider closing three schools. Why would they want to, why it's controversial, and what happens next.

MAY 24, 2013; 7:34 AM • BY [JOHN MURDEN](#)



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The [School Board of Richmond Public Schools](#) has scheduled two public meetings over the next few weeks to discuss a proposal to close three schools. Closing the schools would mean rezoning those students to new schools.

WHY WOULD THE SCHOOL BOARD WANT TO CLOSE SCHOOLS?

Simply put, the school system is spending money maintaining and staffing more buildings than are needed to educate the students in the system.

We have too many schools for the number of students we have. With the way enrollment has declined, it's just not feasible to keep open 50 buildings.
—Glen Sturtevant, 1st District representative (*Times-Dispatch*)

The elementary enrollment in RPS fell from 14,168 in 2001-2002 to 12,014 in 2011-2012, a drop of 2,154 students or about 15%. The number of active elementary schools has dropped in that time from 34 to 28. The [Population and Enrollment Forecasts, 2011-2021 \(PDF\)](#) predicts further continued drops in enrollment, saying that “all but one of the elementary attendance areas show a net decline in students for the period 2016 to 2021.”

Richmond Public Schools [began the rezoning process in October 2011 \(PDF\)](#) to take “a comprehensive look at the existing Richmond Public School zones and facilities.” The 6th District’s Shonda Harris-Muhammad served as Chairperson of the Rezoning Committee which ultimately suggested closing four elementary schools—though Clark Springs Elementary School was not on that list.

Closing under-enrolled schools to strengthen the school system’s budget has been a topic of discussion for years. Most recently, after rounds of public meetings held by the Rezoning Committee through 2011 and 2012, there seems to be broad consensus that schools need to be closed to more accurately reflect the actual student population of the city. None of the School Board members have said that they are opposed to the closing of schools in the abstract.



Clark Springs Elementary School

SO WHAT IS THE CONTROVERSY?

The issues getting the most attention are the potential closing of Clark Springs Elementary School and the timing of the proposed changes. Opponents say that this is much too late in the year to close schools for the next year, and doing so at this time places a burden on the system and the community. Supporters say that the School Board must take this step to make the system viable financially, and available money must be used to best provide for the students.

The School Board initially voted in February to begin the process of closing schools. The current School Board, with seven of the nine representatives newly elected in November and in office only since January, were lauded for coming to City Council with a balanced budget. They were able to erase a deficit of almost \$12 million—with some of the savings based on closing as yet unnamed schools.



Mamie Taylor (5th District)

The School Board then [reversed itself in April](#). Two things happened here: the 5th District's Mamie Taylor proposed keeping the schools open [because one of the most likely to close \(Clark Springs ES\) is in her district](#), and she was supported by a enough of the Board who felt that April was too late in the year to announce school closures for the next school year. This put the School Board in the position of then needing to find the \$1,000,000 originally expected be saved through the facilities closings.

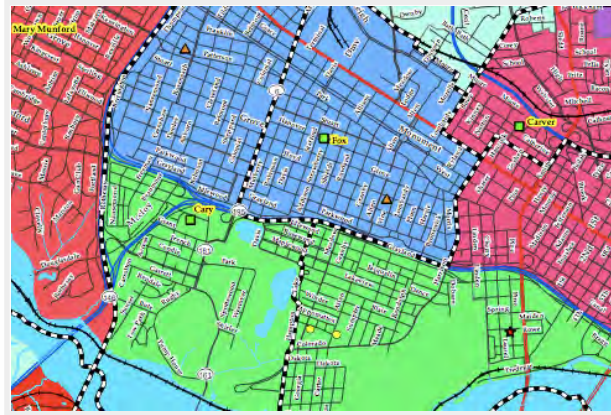
In May, the School Board [once again voted to begin the process of closing schools](#), placing Clark Springs Elementary School, the Adult Career Development Center, and the old Norrell Elementary building ([currently hosting a somewhat controversial pre-k program](#)) on the chopping block.

WHY CLOSE CLARK SPRINGS SPECIFICALLY?

Clark Springs ES and two [equivalent](#), adjacent schools are under-enrolled: there are not enough students at these schools to have them all remain open. Clark Springs ES currently has a gerrymandered draw zone that pulls students from well outside of it's neighborhood.

In [the 2011-2012 school year](#), Clark Springs enrolled 311 students, though the school is allowed 432 under RPS guidelines. To the west, John B. Cary enrolled 199 (of an allowed 507). To the north, Carver enrolled only 479 out of an allowed 890. The newly proposed zoning closes Clark Springs, and for the most part divides the students among Carver and John B. Cary. This increases enrollment at two under-enrolled schools, while achieving the savings of closing the Clark Springs building.

Closing Clark Springs also allows for school zones which [many favor as reflecting "neighborhood schools"](#). With Clark Springs currently acting as the catch-all district for downtown and west-central Richmond, [the school's draw zone stretches from Highland Park in Northside to Byrd Park in the West End](#). With the closure of Clark Springs, the Museum District, the area from City Stadium to Oregon Hill, and the area around Carver would all have schools zones more akin to their neighborhoods. Some believe that this would have the effect of bringing students back into the public school system who do not currently participate.



Proposed zone for John B. Cary Elementary School

WHY NOT CLOSE CLARK SPRINGS?

Opponents of the closing say that Clark Springs is a good school and that the proposed rezoning is flawed. Others believe that it is simply too late in the year to close schools for the next school year.

5th District Representative Mamie Taylor says that Clark Springs should not be closed because, "I am especially opposed to closing Clark Springs, which is a [high performing school](#) that allows students, as does Fox, the opportunity to go outside of their zoned neighborhoods to experience a top of the line education. [...] It provides its students with a top-notch education, dedicated staff, and a family-like setting. I think that it is unfair to place Clark Springs on the table for closure without even considering any other schools."

She also asserts that the proposed Plan C rezoning is flawed: "it appears to segregate our schools and it limits the ability for families to have access to high performing schools through open enrollment."

One of the features of Plan C is that [the Museum District would be a part of the Fox Elementary zone](#). There is a chance that pulling these students out of Cary ES would impact the diversity of that school (78% black, 13% white, 6% hispanic / [2011-2012 RPS](#)). Expanding the number students zones for Fox ES would also have the effect of decreasing the number of available spots for [open enrollment](#) at the popular school.

I will never support closing schools in May. We should not do this right now... it's just not good business. It's not building a good relationship with our community.

—6th District representative Shonda Harris-Muhammad (Times-Dispatch)

There are a number of members of the School Board who do not necessarily oppose closing Clark Springs, but who feel that it is too late in the year to be closing schools for next year. There will be inconveniences and complications in closing a school only four months before students and teachers are to report to school again. Almost [all of the elementary schools north of the river](#) would see some rezoning changes, about which parents would need to be notified. Further complicating the picture, the superintendent of Richmond Public Schools Dr. Yvonne Brandon will be stepping down on June 30.

OK, NOW WHAT?

There are two public meetings scheduled:

- Tuesday, May 28th 5:30PM at Thomas Jefferson High School
- Monday, June 3rd 5PM in Council Chamber at City Hall

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Richmond School Board may consider rezoning to remedy ongoing issues



By Candice Cole (<http://wric.com/author/candice-cole/>)

Published: March 7, 2017, 6:14 pm



RICHMOND, Va. (WRIC) — Overcrowding, school violence, and years of maintenance problems are just some of the issues that have Richmond School Board members considering new options.

Norman Boswell is a parent whose daughter attends a Richmond middle school and often comes home frustrated because she does not get the kind of attention that she needs from her teachers due to overcrowding.

"One of her classes, I think she has like 37 students," he said. "It's kind of hard when you have 37 students and one teacher."

Jonathan Young, who represents the fourth district, told 8News, “we have some schools that are busting at the seams that are overcrowded, then we have some schools that could increase their capacity.”



According to Young, RPS is bleeding money hand-over-fist when it comes to school infrastructure. He said rezoning and school consolidation would allow them to improve the school system in a big way. However, Young also says there needs to be a change within the schools’ culture, regardless of where students attend.

“Frankly, we have some really big issues in this town pertinent to education and we’ve got to fix them, we’ve got to fix them right now,” Young said. “Our kids deserve a lot better than, unfortunately, a lot of them have right now.”

“Our kids deserve a lot better than, unfortunately, a lot of them have right now.”

While no plans have been made yet, Young says the decision will require a lot of public input before anything is put in motion.

“It’s something that can’t be done on the back of a napkin”, says Young, “but we’ve got to do it this year. I think most persons recognize we have to do it this year.”

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Richmond School Board may consider rezoning to remedy ongoing issues

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Richmond School Board signals action on redistricting and rezoning, possibly soon

By K. BURNELL EVANS Richmond Times-Dispatch Mar 6, 2017



The problems have only worsened since they were cataloged in plans proposed in 2002, 2007 and 2012 that have since collected dust on office shelves.

The latest iteration — in 2015 — brought fresh hope that Richmond Public Schools' facilities woes would finally meet an end: Gone would be leaking roofs, ancient HVAC systems and the ear-busting din of elementary schools without functional walls.

But the city's ability to take on debt for the heavy lifting envisioned by plan architects remains hamstrung by a decade of spending on big-ticket items such as a jail and some new schools.

Faced with the reality that the more than half a billion dollars needed to address the district's buildings will likely not materialize, members of a freshman Richmond School Board on Monday signaled action on redistricting and rezoning — possibly within the year.

"I think as a board, as a new board, we will have failed if we neglect in this first year to initiate rezoning and consolidation of schools," said Fourth District representative Jonathan Young.

"We are bleeding money hand over fist in our capital outlay."

Last spring, the board's then-members, none of whom remain, voted for what was then billed as a stopgap measure to maintain and expand portable facilities at overflowing schools in the city's South Side.

The specter of rezoning or funding additions for Fox, Fairfield, Francis and Holton elementary schools also was raised.

"There's a train wreck getting ready to take place," Assistant Superintendent Tommy Kranz said then, adding that the district needed "to begin work tomorrow."

Tomorrow has arrived.

There are 19 modular units at E.S.H. Greene Elementary School and 24 more at Broad Rock Elementary School. Enrollment is swelling at Elkhardt-Thompson Middle, as a result of a merger necessitated by the closure of a school building riddled with mold, and climbing at George Wythe High School.

The schools are aging, outsized in some places and cramped in others, resulting in a tangled mess of wants and needs that administrators say keep them up at night.

"We're going to have to make some tough choices with the rezoning and redistricting processes to stop the bleeding," Superintendent Dana T. Bedden told the board hours after Mayor Levar Stoney unveiled the first budget proposal of his administration to the Richmond City Council.

That proposal included an additional \$7.3 million for school building needs through fiscal 2022, a fraction of the School Board's request for \$207.4 million.

Of that, about \$105 million was to go toward right-sizing the district. The rest was slated for bus replacement and building upkeep.

Although budget talks between the board and the Stoney administration have been marked by cooperation uncharacteristic of city and schools leaders in recent years, not even the gleam of a fresh start and renewed commitment to cooperation can outshine the glaring realities of decades of deferred maintenance.

"RPS has never received the appropriate allocations to maintain our facilities. Just the basics — the bare basics," said School Board Chairwoman Dawn Page, who represents the 8th District.

At George Mason Elementary School, maintenance workers recently replaced mechanical systems in 19 classrooms that for years had overflowed, damaging portions of floors that also had to be replaced.

Patching things is much costlier in the long run than building new, Kranz said. But even the comprehensive plan that he helped develop in recent years relies on a mixture of new construction, additions, redistricting and rezoning.

There's no silver bullet, he told board members during a presentation on vandalism and past spending on school capital projects.


"Honestly, because of the way the zones are today and where the growth is and where the empty seats are located, it becomes a very significant challenge to address through redistricting and rezoning alone," Kranz said.

Officials expected the first, five-year phase of what was initially pitched as a 15-year plan to cost \$169 million.

The board included \$8 million of that in its \$41.6 million request for capital funds in the next fiscal year.

Stoney proposed \$1.6 million for school maintenance in the 2018 fiscal year. The city will have only \$812,000 for the year beginning July 1 to address its own mounting facilities needs.

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'I'll help carry boxes': Richmond School Board members debate closing 'deplorable' elem... Page 1 of 7

http://www.richmond.com/news/local/city-of-richmond/i-ll-help-carry-boxes-richmond-school-board-members-debate/article_d6d28a19-0d7f-5116-af95-c9ad099a6aa8.html

'I'll help carry boxes': Richmond School Board members debate closing 'deplorable' elementary school

By K. BURNELL EVANS Richmond Times-Dispatch Jul 17, 2017



School Board member Felicia Cosby listened during Monday's meeting. In addition to facilities, the board d agreement with the state to boost academic performance.

SHABAN ATHUMAN/TIMES-DISPATCH

While several Richmond School Board members called for debate Monday about the possibility of removing elementary students from the most downtrodden school building in the district, others advised caution at a time of transition.

In the crosshairs is George Mason Elementary School, a squat, century-old brick building in Church Hill long considered to be in worse shape than 43 others in Richmond Public Schools' portfolio.

Teachers there sometimes wear surgical masks in class, and mark the day by wiping rodent droppings from students' desks. Windows, heating and mechanical systems need at least \$5 million in repairs. Decades of plumbing issues have left their mark.

"I'll help carry boxes," said 4th District Board member Jonathan Young.

But with 48 days remaining until students are scheduled to return, School Board Chairwoman Dawn Page said her colleagues were "going down a slippery slope."

"I think it is unfair to the administration, not giving them the opportunity to vet this process, to plan properly," Page said after initially declining to allow a discussion of facilities issues. "You want to play politics at the expense of our children."

Mason and a broader approach to re-energizing dormant talks of rezoning and right-sizing the district's outdated schools were included on the agenda Monday but only as informational items. Page eventually voted for talks to proceed.

"The stories (about our schools) are disheartening, but I'm not quite sure if we're hearing from the same people," Page said. "When you're carrying an agenda for other people, that's concerning."

The comment drew responses from 1st District board member Liz Doerr and 3rd District representative Cindy Menz-Erb, who have been studying facilities issues and helped draft options for removing students from Mason in the coming school year.

"I am trying to do what's best for our kids, just like everyone else on this board," Doerr

said.

Menz-Erb said her desire to remove children from Mason boiled down to one thing: When she toured the building this summer, she could not imagine sending her kids there.

"If it's not good enough for my kids, it's not good enough for anyone's kids," she said.

The talks come a month after employees who work at the school wore surgical masks to the board's June meeting in protest of conditions they said were unfair and unsafe.

A site coordinator for Communities in Schools told the board then that children sweltered in many classrooms and needed jackets in others, and that some teachers needed breathing masks to teach. She was unavailable for an interview Monday.

Board members said their testimony added to a growing sense of urgency surrounding the historic institution, which traces its roots back to the first African-American school in the Church Hill area.

The eight options the board is scheduled to consider include:

- dispersing Mason students across Woodville, Fairfield, Chimborazo and Bellevue elementary schools;
- moving students into Franklin Military, which would prompt Franklin students to shift to Community High School;
- and shuffling Mason students to the former Clark Springs Elementary School building once Overby-Sheppard students are able to return to their North Side campus upon the completion of renovations there.

"I can't imagine anyone would make a compelling case that their students, teachers and staff don't deserve better than what they have by the start of school," Young said.

Interim Superintendent Tommy Kranz said arranging the closure with so few days remaining before the new school year would be challenging.

"The timing of it is unfortunate; it's just extremely tight," said Kranz, who added that George Wythe High School and Elkhardt-Thompson Middle School are barely in better shape than Mason.

Cost estimates to remove students from the elementary school range from up to \$35 million for a rebuilt, larger school on the high end to \$100,000 associated with a few options that involve moving students around.

Inaction would require \$5 million in emergency investments for boilers, mechanical systems and window replacements, which still would leave larger structural issues untouched, according to a rubric provided to board members.

"We're not taking into consideration how this is going to impact staff teachers, the families, transportation," Page said. "It's a domino effect."

The board ultimately voted to schedule a public hearing at George Mason for community feedback on the possibility of moving students.

Meanwhile, the board pushed back on some aspects of an agreement with the state Board of Education on Monday, citing concerns about autonomy in a potentially decadelong pact to boost academic performance.

The memorandum that is set to come before the state board on July 27 emerged after Virginia Department of Education officials gave Richmond Public Schools low marks nearly across the board in a comprehensive review.

School division leaders invited the scrutiny in hopes of turning the district around, but some board members worry the draft plan from the state that would govern that transformation is too restrictive.

We need “to find a balance where we can get the oversight and review we hope to have from the state but also (preserve) autonomy,” said 2nd District board member Scott Barlow, a lawyer who authored the proposed changes.

Chief among Barlow’s concerns is a provision of the agreement that would require state officials to approve spending of state and federal funds. He asked that state officials instead review spending.

He also recommended loosening a proposed rule that the oversight remain in place for up to 10 years, during which the division’s schools all must meet the state’s full standards for accreditation.

Only 17 of the division’s 44 schools were fully accredited in the 2016-17 academic year, placing it among the worst-performing districts in the state.

Barlow’s motion to send the revisions to state officials was voted down by Page; Patrick Sapini, 5th District; and Felicia Cosby, 6th District. 7th District Board member Nadine Marsh Carter was absent.

“As representatives elected by our constituents to oversee administration of our school district, we still believe it is necessary to maintain a level of autonomy regarding the selection of our new superintendent and the expenditure of funds allocated to RPS,” reads a statement the board voted 5-3 to send to the Board of Education.

Some issues identified in the revisions had already been addressed, according to interim schools chief Kranz, who met with his state counterpart, Steven R. Staples, earlier Monday.

That conversation yielded a relaxed approach to the Richmond board’s selection of a new superintendent, who the state previously had specified must have demonstrated experience in turning around a struggling school system.

The news was welcomed by Young, the 4th District representative who has been outspoken in his desire to pursue a new schools chief with an entrepreneurial or military background.

The state also agreed to open mandated progress meetings between the board chairwoman and Staples to the entire School Board.

Kranz assured the board ahead of a vote on Barlow's motion that Staples had no desire to micromanage Richmond's operations.

"(The agreement) is not intended to be ... usurping the power of the School Board," Kranz said.

As of now, the corrective action plan the state has charged Richmond with implementing contains 49 individual mandates, which Kranz said will take between months and years to fix.

Those actions arose from a hard look at five categories the state assessed in an on-the-ground review last spring. Richmond scored lowest on leadership and governance and human resources tools.

The division also lost many points because its latest strategic plan, which expired in 2015, lacked a vision statement.

Of the 25 subcategories for which Richmond schools received a score, only two — professional development and support evaluation, and the legal counsel component — were considered to be fully implemented.


The division received 17 scores of one or below, including seven "zeroes" for categories ranging from evidence-based facilities and maintenance practices to hiring and retention customs.

'I'll help carry boxes': Richmond School Board members debate closing 'deplorable' elem... Page 7 of 7

Kranz warned that up to \$30 million would be at stake should Richmond fail to comply with the terms of the agreement, but he added that the state had full faith in the board.

"They believe that in 10 years it can be done," he said.

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